

## **Attachment 1**

### **Specifications**

**Relocate Doppler VOR/DME, Ft Lauderdale, Florida**  
**SIR/RFP/RFO Number: DTFAEN-12-R-00075**



# **FT. LAUDERDALE – HOLLYWOOD INTERNATIONAL AIRPORT**

**Ft. Lauderdale, Florida**

## **RELOCATE DOPPLER VOR/DME**

### **FINAL SUBMITTAL**

**March 21, 2012**

**PREPARED FOR:**

**FEDERAL AVIATION  
ADMINISTRATION  
EASTERN SERVICE AREA**

**PREPARED BY:**

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None Used

**SECTION 02050**  
**DEMOLITION AND REMOVALS**

**PART 1 - GENERAL**

- 1.1 **Scope:** The procedures proposed for the accomplishment of demolition and removal work shall be submitted. The procedures shall provide safe conduct of the work, careful removal and disposition of materials specified to be salvaged, protection of property, which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation and the sequence of operations.

**PART 2 - PRODUCTS** Not used.

**PART 3 - EXECUTION**

- 3.1 **General:** Demolition and removal work shall be in compliance with approved demolition procedures and applicable requirements of the applicable agencies having jurisdiction.
- 3.2 **Protection Of Existing Work:** Before beginning any cutting or demolition work, the Contractor shall carefully survey the existing work and examine the drawings and specifications to determine the extent of the work. The Contractor shall take all necessary precautions to ensure against damage to existing work that will remain in place, be reused, or remain the property of the Government, and any damage to such work shall be repaired or replaced so as to be equal to or better than the pre-construction condition as approved by the FAA at no additional cost to the Government. The Contractor shall carefully coordinate the work of this division with all other work and construct and maintain any necessary protective structures.
- A. **Dust Control:** Any dust resulting from removal shall be controlled to prevent the spread of dust and to avoid creation of a nuisance in the surrounding area. Existing communications and electronics equipment is acutely sensitive to dust and must be safeguarded. Use of water or other materials shall not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding or pollution.
- B. **Protection Of Buildings From The Weather:** The interior of all shelters and other structures shall be protected from the weather at all times. Material and equipment shall be protected from the weather as recommended by the manufacturer.
- C. **Burning:** Burning at the project sites for the disposal of refuse and debris will not be permitted.
- D. **Use of Explosives:** The use of explosives and pyrotechnics for demolition is not permitted.
- 3.3 **Disposition Of Equipment And Materials:**
- A. **Title To Materials:** All fixtures (installed property) removed during construction shall be designated as either "salvage", "unsalvageable", or "rubble" by the FAA.
- B. **Designation Of Government Salvage, Unsalvageable Property Or Rubble:** All fixtures desired for salvage shall be designated as "Salvage" by the FAA or designated representative. **Items designated as "Salvage" are indicated on the drawings.** All remaining materials and equipment not designated as salvage are "Unsalvageable Material" or "Rubble".



- C. **Disposition Of Unsalvageable Material:** The Contractor shall remove all unsalvageable materials and rubble from the work areas. The unsalvageable materials and rubble removed from the work areas shall be disposed of by the Contractor at an approved off-site location at the Contractor's responsibility and expense, and in accordance with all governmental agencies having jurisdiction.

**3.4 Cutting And Patching:**

- A. **Cutting and Drilling:** The Contractor shall be held responsible at all times for contents and structural conditions of the premises and building within the work area, and shall do or supervise all cutting, drilling, reinforcing, and patching required for work of all the Subcontractors and trades included in work of this Subcontract, and to do so in a timely manner to avoid any hindrance to work of other trades. Cutting done by anyone other than the Contractor shall be approved by the FAA. In such cases the Contractor shall supervise such cutting and shall not be relieved of responsibility for error or damage to related or adjoining work. Cutting and patching of specific items may be separately described under the various divisions of these specifications that do not, in any way, diminish the Contractor's primary responsibility for all cutting and drilling.
- B. **Patching:** Any cutting of finished surfaces or damage thereto occurring in the course of the work shall be patched and/or repaired to match the existing work in color, texture, alignment, and every other respect to the satisfaction of the FAA. Materials shall be equal to or better than the pre-construction condition.
- C. **Repair of Masonry Walls:** Openings in masonry walls shall be closed with 16 gauge galvanized steel sheet securely attached at the midpoint of the wall thickness and firestopped on both sides of the steel sheet with not less than 1/2-inch thick layer of non-sagging silicone elastomer to fully cover the opening.

**3.5 Quality Assurance:** The Contractor shall establish and maintain quality control for the demolition and removal work to assure compliance with subcontract requirements. Records shall be maintained for all demolition and removal operations but not limited to the following:

- A. **Procedures:** Safety measures, protection of property, coordination of work, and dust control.
- B. **Salvaging:** Removal and preparation of materials for storage.
- C. **Demolition:** Extent of demolition and disposition of materials.

**3.6 Clean-Up:** The Contractor shall remove debris and rubbish from the site daily. Do not allow debris to accumulate in building nor on-site. Remove debris and excess materials.

- A. **Debris Control:** The Contractor shall remove and transport debris in a manner as to prevent spillage on streets or adjacent areas. The Contractor shall immediately clean up any spillage or tracking of soil or debris onto pavement outside the work area.
- B. **Regulations:** The Contractor shall comply with all regulations regarding hauling and disposal of removed materials. The legal disposal of removed materials and debris is the Contractor's responsibility.

END OF SECTION

**SECTION 02200**  
**EARTH WORK**

**PART 1 - GENERAL**

**1.1**     **Section Includes:** This Section includes the excavation and backfilling requirements for underground utilities and appurtenances as well as access roads, foundations, and parking areas.

**1.2**     **Work Included:** The work under this Section includes, but is not limited to the following:

- A.     Preparing sub-grades for pads, and foundations.
- B.     Sub-base courses for maintenance areas slabs-on-grade, walks, and pavement.
- C.     Backfilling for utilities.
- D.     Removal of foundations and underground utilities indicated on the construction drawings.
- E.     General excavation and fill to include stripping and salvaging top soil, segregating and stockpiling soil, and spreading topsoil.
- F.     Excavation required for installation and maintenance for erosion and sediment control.
- G.     Protection of Underground Utilities.
- H.     Miscellaneous excavation to include fence post.

**1.3**     **Related Sections:**

Section 02220	Installation of Underground Cable
Section 02270	Prevention, Control, and Abatement of Erosion and Water Pollution
FAA-C-1391b	Installation and Splicing of Underground Cables

**1.4**     **Standards and References:** The current issues of the following documents in effect on the date of the request-for proposal form a part of this specification and are applicable to the extent specified herein.

A.     Unless otherwise indicated on the Construction Drawings or herein specified, all work under this Section shall be performed in accordance with the current Florida Department of Transportation, (FDOT), Standard Specifications for Roads and Structures.

B.     **American Association of State Highway and Transportation Officials (AASHTO):**

T-99– Moisture-Density Relations of Soils Using 5.5 lb (2.5 Kg) Rammer and 12-in. (305 mm) Drop.

C.     **American Society of Testing and Materials (ASTM) Publications:**

ASTM D-1557     Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.

ASTM D-2487     Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

ASTM D-4253      Standard Test Methods for Maximum Index Density and Unit Weight of  
Soils Using a Vibratory Table

ASTM D-4254      Standard Test Methods for Minimum Index Density and Unit Weight of  
Soils and Calculation of Relative Density

**D.    Natural Resources Conservation Service, (NRCS)**

**1.5    Definitions:** The following terms shall mean the following for this contract:

- A.    Excavation:** Consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.
- B.    Sub-grade:** The uppermost surface of an excavation, or the top surface of a fill or backfill, immediately below sub-base, drainage fill, or topsoil materials.
- C.    Sub-base Course:** The layer placed between the subgrade and base course in a paving system, or the layer placed between the subgrade and surface of a pavement or walk.
- D.    Base Course:** The layer placed between the sub-base and surface pavement in a paving system.

**1.6    Submittals:** The following items shall be submitted:

- A.    Gradation and compaction reports.**
- B.    Name of site-material source and load ticket for each delivery.**
- C.    Name of testing firm/lab.**
- D.    Vendor data for erosion control materials**
- E.    As-Built drawings**

**PART 2 - PRODUCTS**

**2.1    Soil Materials:**

- A.    Sub-base and Base Material:** Naturally or artificially graded mixture of crushed limestone, size gradation of No. 57, 67, or similar locally available approved equal as defined by Florida Department of Transportation Standards for sub-base course.
- B.    Engineered Fill:** Sub-base or base materials.
- C.    Foundation Backfill:** Foundation backfill shall be crushed stone, well-graded from coarse to fine, other aggregate, or an approved sand-gravel mixture. No overburden or decomposed and disintegrated rock allowed. The material shall meet the following gradation: 100 percent passing a 1 1/2 inch sieve, 80-100 percent passing a 1 inch sieve and 0-5 percent passing a No. 8 sieve.
- D.    Filtering Material:** Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing a 1-1/2 inch sieve and 0 to 5 percent passing a No. 50 sieve.



- E. **Earth Fill:** Approved type of soil classified as GW, GP, GM, GC, SW, SP, SM, SC, ML or CL according to the Unified Soil Classification System and free of foreign substances, obtained from excavation for this construction or an approved source and having a plasticity index of 20 or less. Excavated material that meets the requirements for earth fill may be used for filling, backfilling, and grading.
- F. **Suitable Material:** Any on-site excavated or borrow material meeting the requirements of "Earth Fill" as defined above shall be considered "Suitable" or "Satisfactory" material for construction of fills, backfills or embankments.
- G. **Unsuitable Material:** Any material construction debris containing roots or other organic matter, such as peat, organic silt, or sod, shall be considered unsuitable for use as backfill material or for embankment construction.
- H. **Top Soil:** Top layer of soil containing organic material suitable for growing grass and other vegetative materials, free of roots, debris, and other deleterious materials. Topsoil from an off-site location must be from an approved source and have similar characteristics as the on-site topsoil.
- I. **Granular Filter:** A transitional layer of gravel placed between the underlying soil and rip rap. Material shall conform to FDOT standards and have an AASHTO gradation of No. 67

## 2.2 **Geosynthetics**

**Geosynthetic Material:** Woven or non-woven plastic fabric used for soil separation as defined in the Florida Department of Transportation Standards for their respective use. Geosynthetic material for sediment control shall follow Florida Department of Transportation standards unless otherwise directed by the FAA.

## **PART 3 - EXECUTION**

### 3.1. **Demolition of Existing Utilities:**

- A. Demolish and completely remove from site existing underground utilities indicated to be removed.
- B. Comply with FAA instructions as to removal or marking of any abandoned or previously unknown utility.
- C. Coordinate with utility companies to shutoff services if lines are active.

### 3.2 **Excavation:**

- A. Excavation shall be to the contours and dimensions indicated. Notify the FAA and Subcontract Administrator immediately in writing in the event that it becomes necessary to remove hard, soft, weak, or wet material to a depth greater than indicated, in order for any adjustment in subcontract price to be considered. Excavations cut below the depths indicated shall, unless otherwise specified, be backfilled with fill or granular fill and be compacted in a manner acceptable to the FAA.
- B. **In Case Of An Accident And/Or Damage To An Existing Utility, The Contractor Shall:**
  - 1. Immediately contact the FAA and Airport Emergency Services or facility manager, in case evacuation is required. Follow the Emergency Procedures Plan.
  - 2. Immediately report all damages, including kinking or sheath damage to the FAA. Notify facility owner or operator as directed by the FAA.

- C. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.
- D. Preserve, protect and maintain existing operable drains, sewers, and electrical ducts during grading, excavating and backfilling operations. Keep excavations dry. Locations indicated for existing utility facilities are approximate. Pipes or other manmade obstructions, in addition to those indicated, may be encountered. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Perform all work adjacent to non-Airport utilities as indicated in accordance with procedures outlined by utility owner. Excavation made with power driven equipment is not permitted within five feet of any known existing utility. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered. Support uncovered lines until approval for backfill is granted by the FAA.
- E. Excavation shall be performed so that the area of the site and the area immediately surrounding the site and affecting operations at the site will be continually and effectively drained. Water shall not be permitted to accumulate in the excavation. The excavation shall be drained by pumping or other satisfactory methods to prevent softening of the foundation bottom, undercutting of footings, or other actions detrimental to proper construction procedures. Sediment from dewatering operations shall be controlled prior to off-site release.
- F. Plan for and provide the equipment and construction for the collection and disposal of surface and subsurface water encountered in the course of construction.
- G. Where it is necessary to cross paved areas, permission of the FAA shall be obtained before starting any pavement cuts and trenching. The pavement surface shall be saw-cut to a minimum depth of 2 inches. Lines shall be straight and true to ensure a neat finish between the existing and restored surfaces. The width of excavated pavement shall extend 1 foot and 6 inches beyond each side of the proposed excavated width for the trench in the subgrade below. All rubble and waste material from this operation shall be completely removed from the site.
- H. Where existing paved surfaces have been removed to allow for utility line crossings, backfill trenches as specified below. Replace the pavement with material of thickness and proportions that are as near to those of the existing pavement as can practically be accomplished, or as otherwise specified.
- I. Satisfactory excavated material shall be re-used in the work. No excavated material shall be disposed of in such a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.
- J. When excavations have reached the required elevations, the Contractor shall not proceed with further construction of the excavated area, until the area has been inspected by the FAA.
- K. **Excavate trenches to indicated slopes, lines, depths, and invert elevations:**
  - 1. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
  - 2. Clearance: A minimum of 12 inches (300 mm) each side of pipe or conduit.
  - 3. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading. For pipes or conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms, and support pipe and conduit on an undisturbed subgrade. For pipes and conduit 6 inches (150 mm) or larger in



nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

- L. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- M. **Rock Excavation:** When rock conditions are encountered during excavations for slabs, footings, or foundations, all material in the excavation area shall be removed to a depth of 6 inches below the bottom of the excavation grade and replaced with suitable material. Over excavation is not required if excavation reveals solid rock at the bottom of the excavation grade and no potentially faulty bearing surfaces, such as soil or crumbling rock, are apparent by visual inspection by the FAA. Rock encountered during footing excavations shall be leveled to a clean, even, hard surface at the indicated grade. No footings shall be permitted to rest partly on soil and partly on rock. In the event that excavation reveals potential foundation bearing surfaces of part rock and part soil, the Contractor shall contact the FAA for resolution of the problem.

### 3.3 **Backfill:**

#### A. **General**

1. Prior to backfilling, the owners/operators of existing facilities/utilities that were exposed during potholing or excavation shall be contacted and given the opportunity to inspect for damage that may have occurred during the excavation process. All responses and inspections shall be documented.
2. The Contractor shall take care not to damage existing facilities and utilities during backfill and compaction.
3. All material used to backfill potholed or excavated existing utilities shall be clean and free of large rocks, sharp objects, and large chunks of hard-packed dirt or clay. The requirements for backfill may be found in FAA-C-1391, Installation and Splicing of Underground Cables. The utility owner/operators shall be contacted for additional requirements regarding their utilities.

#### B. **Foundation Backfill:** Backfill excavations promptly with Foundation Backfill, but not before completing the following:

1. Acceptances of construction below finish grade including, where applicable, damp proofing, waterproofing, perimeter insulation and underground utilities.
2. Concrete formwork removal.
3. Removal of trash, debris, any deleterious materials, and unsuitable soil materials from excavation.

#### C. **Backfill Material:**

1. Preparation: Remove vegetation, topsoil, debris, wet, and unsuitable soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.
2. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.
3. When subgrade or existing ground surface which is to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density as indicated in this specification.
4. Place fill material in layers to required elevations for each location listed below. Flooding is not permitted.
5. Under grass, use suitable excavated or borrow soil material; except for the top 3" where topsoil material shall be used.
6. Under walks and pavements, use sub-base or base material or suitable excavated or

- borrow soil materials.
- 7. Under footings and foundations, use engineered fill.

**D     Moisture Control:**

- 1. Uniformly moisten or aerate sub-grade and each subsequent fill or backfill layer before compaction to within 4 percent of optimum moisture content for on-site clayey soils and to within 2 percent of optimum moisture content for relatively non-expansive soils as determined by ASTM D-1557.
- 2. Do not place backfill or fill material on surfaces that are muddy or exceed allowable moisture content.
- 3. Remove and replace, or scarify and air-dry suitable soil material that is too wet to compact to specified density.
- 4. Stockpile or spread and dry removed wet suitable soil material.

**E.     Compaction:**

- 1. Place backfill and fill materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- 2. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.
- 3. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D-1557.
  - a. Under existing building foundation compact the top 12 inches below subgrade and each layer of backfill or fill material to 95 percent maximum dry density.
  - b. Under walkways, compact the top 6 inches below subgrade and each layer of backfill or fill material to 95 percent maximum dry density.
  - c. Under lawn or unpaved areas, compact the top 6 inches below subgrade and each layer of backfill or fill material to 90 percent maximum dry density.
- 4. Trench Compaction Requirements:
  - a. Compact earth fill and cohesive aggregate fill in maximum 6 inch lifts with pneumatic rollers or power hand tampers and make a minimum of eight (8) passes.
  - b. Compact cohesionless aggregate fill in maximum 6 inch lifts with vibratory rollers or vibratory plate power hand compactors and make a minimum of eight (8) passes.
  - c. The acceptability of the compaction equipment shall be based upon the results of a test section.
  - d. Compact earth fill and cohesive aggregate fill to a minimum of 95% of maximum dry density as determined by ASTM D-1557, Standard Proctor by using nuclear methods.
  - e. Compact cohesionless aggregate fill on which it is not practical to control the density by "Proctor" methods to a minimum of 75% of relative density as determined by ASTM D-4253 and D-4254, by a field compaction mold method correlated to ASTM D-4253 and D-4254. Compact cohesionless aggregate fill at a moisture content within a range that accommodates consistent placement and compaction to the minimum relative density specified above.

**F.     Grading:**

- 1. General: Uniformly grade areas to a smooth surface free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - a. Provide a smooth transition between existing adjacent grades and new grades.
  - b. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.



2. Site Grading: Slope grades to direct water away from structures and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
3. Lawn or Unpaved Areas: Plus or minus 1 inch.
4. Walks: Plus or minus 1 inch.
5. Pavements: Plus or minus 1/2 inch.

**G. Sub-base and Base Courses:** Under pavements and walks, place sub-base course material on prepared subgrades. Place base course material over sub-bases to pavements.

1. Grade and compact sub-base and base courses to grades, lines, cross sections and thickness to not less than shown on the Construction Drawings.
2. Shape sub-base and base to required elevations and cross-slope grades.
3. When thickness of compacted sub-base or base course is 6 inches or less, place materials in a single layer.
4. When thickness of compacted sub-base or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

**H. Drainage Fill:**

1. Under slabs-on-grade, place drainage fill of course aggregates on prepared subgrade.
2. Compact drainage fill to required cross sections and thickness.
3. When compacted thickness of drainage fill is 6 inches or less, place materials in a single layer.
4. When compacted thickness of drainage fill exceeds 6 inches thick place materials in equal layers, with no layer more than 6 inches thick nor less than 3 inches thick when compacted.

**I. Field Quality Control:**

1. General: The Contractor will employ a testing laboratory to perform tests and to submit test reports. Sampling and testing for quality control during placement of fill, base, and/or subgrade shall include the following:
  - a. Testing Agency Services: Allow testing agency to inspect and test each subgrade, sub-base, and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements. Unless otherwise specified in the plans or these specifications, all testing shall be in accordance with Florida Department of Transportation standard procedures.
  - b. Footing Subgrade: At footing subgrades, perform at least one test of each soil stratum to verify design-bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of each subgrade with related tested strata when acceptable to the FAA.
  - c. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests per layer.
  - d. Below Specified Density: When testing agency reports that subgrades, fills, backfills, subbase or bases are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, re-compact and retest until required density is obtained, at no additional cost to the government.

**J. Disposal of Surplus and Waste Materials**

1. Disposal: Transport surplus suitable soil to designated storage areas on the Airport's property. Stockpile or spread soil as directed by FAA. Protect stockpiles from erosion. Stabilize stockpiled material as directed by the FAA.

2. Removal: Remove waste material, including unsuitable soil, trash, and debris, and legally dispose of it off the Airport's property.
3. Burning: No burning of materials shall be permitted on the site.

**END OF SECTION**

**SECTION 02205**  
**WALKWAYS AND GRAVELED AREAS**

**PART 1 – GENERAL**

- 1.1 **Work Included:** The Contractor shall provide the necessary materials, labor, and equipment for the construction of walkways, access roads and maintenance areas, as specified herein or on applicable drawings.
- 1.2 **Related Work Covered Elsewhere**
- |                                      |   |
|--------------------------------------|---|
| Section 02200                        | Earthwork   |
| Referenced Specifications            | Codes and Standards   |
| Florida Department of Transportation | Standard Specifications for Road and Bridge Construction. 2007. |
- 1.3 **Submittals**
- A. **Gradation Curves:** The Contractor shall submit a gradation curve for the aggregate materials prior to delivery of material.
- B. **Delivery Tickets:** The tickets shall indicate the delivery date, time dispatched, name and location of the project, name of Contractor, name of supplier, truck number, quantity, and composition.

**PART 2 – PRODUCTS**

- 2.1 **Materials:** The Contractor shall furnish materials for walkways, access roads and maintenance areas in accordance with State of Florida Department of Transportation standards or specifications that meet or exceed the requirements specified herein.
- 2.2 **Aggregate Material:** Aggregate material shall be composed of pit-run gravel, stream-bed gravel, crushed rock, slag, or shell. Material shall not be larger than 1 inch. The aggregate shall be reasonably well graded from coarse to fine, with a maximum allowable 15 percent by volume, and a minimum allowable 5 percent by volume of binding material. Loam shall not be used as a binding material.

**PART 3 – EXECUTION**

- 3.1 **Preparation:** Earthwork and sub-grade preparation shall be in accordance with Section 02200.
- 3.2 **Aggregate Placing:** Aggregate surfaced walkways shall consist of a minimum of 6 inches of washed gravel. Aggregate shall be compacted using a small steel drum roller or other equipment approved by the FAA. Care should be taken by Contractor to avoid crushing aggregate during compaction to avoid unwanted changes in gradation.
- After sub-grade is prepared, place geofabric per plan over the sub-grade immediately prior to placing of aggregate. Lap edges 6" minimum and neatly cut polyethylene sheeting to conform to pads, piers, conduits, etc., within area to receive aggregate surface.
- 3.3 **Quality Control:** The Contractor shall give the FAA, at the time of delivery, two copies of the aggregate delivery ticket.



**END OF SECTION**

**SECTION 02220**  
**INSTALLATION OF UNDERGROUND CABLE SYSTEM**

**PART 1 - GENERAL**

- 1.1 **Work Included:** Installation of underground cable system shall be governed by this section in conformance with FAA Specifications FAA-C-1391.
- 1.2 **Work Access:** The Subcontractor shall perform all work with a minimum disruption to FAA and airport operations.
- 1.3 **Related Documents:**
- |               |           |
|---------------|-----------|
| Section 02200 | Earthwork |
| Section 02324 | Trenching |
- 1.4 **Submittals:** Schedule of cable work shall be submitted to the FAA five (5) days prior to commencement of this phase of work.

**PART 2 - PRODUCTS - NOT USED**

**PART 3 - EXECUTION**

- 3.1 **Coordination Of Work:** The Subcontractor shall coordinate the construction work for this project with those responsible for facility operations.
- 3.2 **Inspection**
- A. **Line and Grade:** Prior to any excavation, the FAA shall inspect all control points established by the Subcontractor.
- B. **Concrete:** Prior to placement, the FAA shall inspect all excavated areas. No fill or concrete shall be placed without the FAA's presence.
- C. **Trenching:** Excavation and backfill for trenching shall be in accordance with Sections 02200 and 02324. All cable trenches shall be inspected by the FAA prior to both installation of cables and backfill. No cable trench shall be left open and unattended. In the event a trench or excavation must be left open overnight, it shall be properly barricaded, flagged, and lighted.
- 3.3 **Cables**
- A. **Installation:** The cable complement shall be as shown on the drawings. The Government will furnish only those cables in the List of Government-Furnished Materials. These items will be made available to the Subcontractor at a specified location prior to date material will be required for incorporation in the work. Installation shall include all trenching, testing, backfilling, locator tape, cable markers, terminations, and conduits.

- B. Termination and Splicing:** Cable will be placed in unspliced lengths. Unless otherwise indicated, the Subcontractor will terminate all cable. All cables not terminated by the Subcontractor shall be left with 25 feet of slack with ends sealed.
- C. Unterminated Cables:** The Subcontractor will make the unterminated ends of all cables watertight as follows: The cable end is to be wrapped with Scotch Electrical Tape No. 33 and then dipped into O.Z. Sealing Compound or equal. The sealing compound will be heated to 375 degrees F prior to dipping the cables, in accordance with the manufacturer's instructions. No direct payment will be made for making the ends of the cables watertight; compensation, therefore, will be included in the price quoted for installing the cables.

**END OF SECTION**

**SECTION 02270**  
**PREVENTION, CONTROL AND ABATEMENT OF**  
**EROSION AND WATER POLLUTION**

**PART 1 – GENERAL**

**1.1     Work Included:** The work covered by this Section shall consist of the Best Management Practices (BMPs) for furnishing, installing, maintaining and removing temporary erosion control devices on the Project and in areas outside the construction limits where work is accomplished in conjunction with the project, so as to prevent pollution of water, air, detrimental effects to public or private property adjacent to the project limits, and damage to work on the project. Where practical, temporary erosion control features shall be constructed and maintained as outlined within the Contractor's approved Erosion Control Plan. Stabilized construction exits are a mandatory BMP on this project.

**1.2     Related Sections:**

Section 02200	Earthwork
Section 02325	Excavation, Backfilling and Compacting for Utilities

**1.3     Standards and References:**

A.     **The American Society for Testing and Materials (ASTM) Publications:** Publications listed in Sections 02200 and 02325 form a part of this specification to the extent referenced.

B.     **Florida Department of Transportation:** Florida Department of Transportation, Standard Specifications for Roads and Structures.

C.     **Natural Resources Conservation Service (NRCS):** Florida Conservation Practice Standards

**1.4     Submittals:**

A.     **Erosion Control Plan:** An Erosion and Sedimentation Control Plan (ESCP) has been prepared for this project and is included in the Construction Drawings. The ESCP shall be the minimum effort necessary to prevent soil erosion and minimize off-site sedimentation. The Contractor may implement an alternative plan provided that said Plan is approved by the FAA, Owner and Owners Engineer prior to implementation and commencement of earth disturbing activities of this project. Any alternative Plan shall depict the BMPs for the erosion control measures, and be submitted within 5 days after NOA. The proposed plans for installation of erosion and sediment control devices shall include a schedule of construction activities, which shall be based on project conditions and shall be in written form. This schedule shall specifically indicate the sequence of earthwork operations and the proposed use of temporary erosion and sediment control features. This plan shall also outline the Contractor's proposed methods of controlling erosion and sedimentation of haul roads and areas used for waste materials from the project. This submission shall include but is not limited to the following:

1. General overall Erosion and Sediment Control Plan;
2. Detailed breakdown of BMPs (erosion and sediment control devices) as required for different stages of construction;
3. Set of marked plans or detailed drawings showing areas of control devices and purpose for each;
4. Subsequent staging plans and specific site plans may be submitted to the FAA for approval as the work progresses. These plans shall be submitted a minimum of two (2) weeks in advance of construction, to allow review by the FAA. No work shall be started until the FAA has accepted the aforementioned plans. The Contractor will be responsible for accomplishment of the work in accordance with the accepted plans. The FAA may have changes approved that are necessary due to unforeseen circumstances that are beyond the control of the Contractor.



- B. Plan Contents:** The plan shall consider, but is not limited to the following:
- a. Overview of Erosion and Sedimentation Control Plan
    - 1. General Requirements
    - 2. Contractor Submittal
      - a). Contractor must review and sign the Erosion and Sedimentation Control Plan
      - b). Contractor must make commitment to provide erosion and sediment control as specified in the Erosion and Sedimentation Control Plan and as directed by the FAA
    - 3. No earth disturbing activities shall commence until acceptance by FAA
  - b. Erosion Control Schedule
    - 1. General Overall Erosion and Sedimentation Implementation Plan (Narrative)
    - 2. Breakdown of Erosion and Sediment Control Devices (Summary of Quantities)
    - 3. Marked Plans or Detailed drawing showing Control Devices and Purposes
    - 4. Site and Staging Plans
  - c. Plan Considerations
    - 1. Terrain
      - a). Hilly
      - b). Flat
      - c). Drainage Area
    - 2. Soil Conditions
      - a). Clay
      - b). Sandy
      - c). Rock
    - 3. Adjacent Property
      - a). Urban
      - b). Rural
      - c). Waterways
      - d). Specific
    - 4. Narrative
      - a). Worksite Erosion Control Supervisor (WECS) identified and listing of relevant qualifications
      - b). Summary of quantities for erosion control devices
      - c). Grassing
    - 5. Plans
      - a). Proximity of drainage ditches, canals, and other stormwater conveyance facilities
      - b). Locations of Construction Exit onto Access/Paved Roadways
      - c). Location of Silt Fence and/or Gates
      - d). Type of Silt Fence.

## **PART 2 – PRODUCTS**

- 2.1. Best Management Practices:** BMPs shall be based on FDOT or Florida NRCS standards unless otherwise approved by the FAA. BMPs may include, and are not limited to:
- a. Construction Exit
  - b. Silt Fence – Reinforced

**PART 3 - EXECUTION**

- 3.1 **Scheduling of Successive Operations:** Operations shall be scheduled such that the area of unprotected erodible earth exposed at any one time is not larger than the minimum area necessary for efficient construction operations and that the duration of exposure of uncompleted construction to the elements is as short as practicable
- 3.2 **Construction Requirements:**
- A. **General:** The FAA has the authority to limit the surface area of erodible earth material exposed by trenching and excavation, and to direct the Contractor to provide immediate permanent and/or temporary erosion control measures to prevent contamination of adjacent drainage ditches, canals, or other areas of water impoundment. Such work should coincide with the Contractor's Erosion Control Plan. Cut slopes shall be stabilized as the excavation proceeds. Under no circumstances shall grading be allowed to exceed the operating range of the stabilization operation. In addition to minimizing erosion, this is necessary to keep attraction to birds, to a minimum. The Contractor shall incorporate all erosion control features into the Project at the earliest practicable time as outlined in his accepted Plan.
  - B. **Erodible Area:** The Contractor shall limit the area of excavation and trenching operations commensurate with the Contractor's capability and progress in keeping the finish grading, sodding and other such erosion control measures current in accordance with the accepted Plan. . In no instance shall any disturbed area or stockpile be left exposed beyond the current work day. All disturbed areas and stockpiles shall be temporarily stabilized with sod, mulch, or non-erosive granular materials at the end of each work day.
  - C. **Maintenance:** All temporary erosion and sediment control measures shall be maintained throughout the duration of the project until final acceptance, or final stabilization of upstream tributary areas. Measures shall only be removed upon approval by the FAA. Silt Fence shall be repaired or replaced at the presence of tears, holes or bulges in the fabric, and shall be re-staked as necessary to maintain compliance with the lines identified in the Erosion and Sediment Control Plan.
- 3.3 **Protection During Suspension of Contract Time** - In the event that it is necessary to suspend the construction operations for any appreciable length of time, the top of the earthwork shall be shaped in such a manner as to permit runoff of rainwater. The FAA has the authority to require the application of temporary sodding and other erosion and sediment control measures to minimize erosion and sediment transport.

END OF SECTION

**SECTION 02324**  
**CABLE TRENCHING**

**PART 1 - GENERAL**

**1.1     Work Included:** Trenches for conduit, ducts, electric and communication cables to be excavated as shown on the Construction Drawings and as provided for by the specifications. Perform all work with a minimum disruption to local operations.

**1.2     Related Documents**

Section 02200	Earthwork
Section 02220	Installation of Underground Cable System
FAA - Specification FAA-C-1391	Installation and Splicing of Underground Cables

**PART 2 - PRODUCTS**

**2.1     Marking Tape:** - 2 inches wide with aluminum core, with continuous word identification "WARNING - UNDERGROUND CABLE", or previously approved alternative wording.

**2.2     Concrete Cable Markers:** - Concrete cable markers constructed and inscribed as depicted in the drawings.

**PART 3 - EXECUTION**

**3.1     Trenching Operations:**

- A.     Protection of Existing Utilities and FAA Cables:** The Contractor shall obtain utility locations from the utility owners (telephone company, electrical power service, water and gas utilities, airport operations, and FAA). FAA will mark its cable locations; provide a minimum of 72 hours advance notice. Contact Sunshine State One-Call of Florida, Inc., for commercial utility marking before digging, and Airport Maintenance for airport lighting and power.
- B.     Hand Excavation:** Excavation by hand is required when excavating within 5 feet of existing utility services when crossing the existing service. Trenches running parallel to an existing utility shall be separated by ten feet.
- C.     Repairs:** Contractor shall be responsible for prompt restoration of service to any facility impacted by construction operations. Contractor shall immediately repair any damage done to utilities or cables within the work area. A certified splicer shall be on call to splice cables. FAA cables shall be repaired to the standards described in FAA Specification FAA-C-1391, Installation and Splicing of Underground Cables
- D.     Marking Tape:** Install in trenches before final placement of fill and compaction at depth of six inches. Overlap ends of rolls a minimum of three feet and tie ends together with a square knot.
- E.     Cable Markers:** Duct and cable markers are required at the beginning point and ending point of each run; at each change of direction; and every 200 feet along the run.



- F. **Cable Installation:** The installation of underground power cables shall be in accordance with Section 02220.
- G. **Backfill:** The backfill of trenches shall be in accordance with Section 02200. Prior to backfill, the Contractor shall record on as-built drawings the location and elevation of existing utilities encountered, and any deviation from the line and grades shown on the Construction Drawings.

**3.2 Inspection:**

- A. **Line and Grade:** Prior to any excavation, all control points established by the Contractor shall be inspected by the FAA.
- B. **Trenching:** All cable trenches shall be inspected by the FAA prior to backfill. Normally, all trenches shall be backfilled on the same day they are excavated. In the event a trench or excavation must be left open overnight, it shall be properly barricaded, flagged, and lighted.

**END OF SECTION**

**SECTION 02325**  
**EXCAVATING, BACKFILLING AND COMPACTING FOR UTILITIES**

**PART 1 - GENERAL**

- 1.1 **Work Included:** The work under this Section includes, but is not limited to furnishing all labor, materials, equipment and incidentals necessary to perform utility trenching, direct burial of conduit, backfilling, handling, storage, transportation and disposal of excavated material; pumping and dewatering; preparation of sub-grades; protection of adjacent property; fills, grading; and other appurtenant work.
- 1.2 **Related Work Covered Elsewhere**
- |               |  |
|---------------|--|
| Section 02200 | Earthwork                                |
| Section 02940 | Grassing (by Sodding)                    |
| Section 16119 | Underground Ducts and Utility Structures |
- 1.3 **Standards and References**
- A. Unless otherwise indicated on the Construction Drawings or herein specified, all work under this Section shall be performed in accordance with the Florida Department of Transportation (FDOT) Standard Specifications for Construction of Roads and Bridges, 2010, or current edition.
- B. American Society of Testing and Materials (ASTM) Publications:
- |             |  |
|-------------|--|
| ASTM D-448  | Standard Classification for Sizes of Aggregate for Road and Bridge Construction                              |
| ASTM D-698  | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort                |
| ASTM D-1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method                    |
| ASTM D-1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort                |
| ASTM D-2487 | Standard Practice for Classification of Soils for Engineering Purposes                                       |
| ASTM D-4253 | Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table             |
| ASTM D-4254 | Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density |
| ASTM D-6938 | Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods    |
- C. Any other testing required by these specifications and not specifically referenced to a standard shall be performed under ASTM or other appropriate standards.
- D. Reference herein or on the Construction Drawings to soil classifications shall be understood to be in accordance with ASTM D-2487, "Standard Practice for Classification of Soils for Engineering Purposes" unless indicated otherwise.

#### 1.4 Job Conditions

- A. Excavations shall include material of whatever nature encountered, including but not limited to clays, sands, gravel, conglomeritic boulders, weathered clay shales, rock, abandoned underground utilities, debris and abandoned existing structures. Excavation and trenching shall include the removal and subsequent handling of materials excavated or otherwise handled in the performance of the work.
- B. Trench excavation shall consist of excavation to the lines and grades indicated, required for installation of direct burial conduit, and backfill.
- C. Suitable material removed from excavations and which is not required for backfill shall be disposed on site as directed by the FAA. Unsuitable material removed from excavations shall be removed and disposed off-site by the Contractor at no additional cost to the FAA.
- D. All work performed shall be coordinated with the FAA to prevent interruptions to the operations of the facility. Provide temporary traffic control measures as necessary.

#### 1.5 Submittals

- A. Gradation and compaction reports, names of material sources and testing lab.
- B. "As-Built" drawings.
- C. Work Plan/Contingency Plan and disconnect location sketch.

### PART 2 - PRODUCTS

- 2.1 **Materials:** Materials shall be as specified in Section 02200, unless otherwise indicated herein. Suitable excavated materials to be used for backfill may be deposited in stockpiles at points convenient for re-handling the material during the backfilling process. The location of stockpiles shall be within the limits of construction. Keep drainage channels clear of stockpiled materials, and control sediment transport. Unsuitable excavated material shall not be used for backfill, and shall be handled in accordance with Section 02200.

#### 2.2 Mixes; Sand-Cement Backfill or Embedment

- A. A minimum sand and cement mixture of 27 parts sand and 2 parts cement will be required.

Fine Sand	1 Cubic Yard
Cement	1 Bag (Minimum)
Water	Potable

- B. Sand shall be free of any cohesive material and shall meet the following gradation and plasticity index requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
1 inch	100
½ inch	95 - 100
No. 40	80 - 100
Plasticity Index	10 Maximum
Liquid Limit	25 or less



### **PART 3 - EXECUTION**

#### **3.1 Preparation**

**A. Site:**

1. Do not remove trees unless indicated on the Construction Drawings or unless their removal is authorized in writing by the FAA. Adequately protect the trees left standing from permanent damage by construction operations. Standing trees may be trimmed where necessary to facilitate construction, but only with written authorization from the FAA.

**B. Protection of Existing Structures and Utilities:**

Existing underground facilities and utility lines shall be protected and located in accordance with Section 02200 and the following:

1. Where construction endangers adjacent structures, utilities, embankments and/or roadways, the Contractor shall, at their own expense, carefully support and protect such structures so that work can be done safely and without damage throughout the construction process. In case damage should occur, the Contractor shall be responsible for restoration.
2. Restore, repair or replace to the satisfaction of the FAA damaged items to a condition equal to or better than the original condition and of same or better material and quality.
3. Protect open excavation from vehicle and pedestrian traffic with barricades and flashing warning lights. Steel plate (1" minimum thickness) may be used over open trenches as temporary roadway. At a minimum, a 12-foot wide lane must be kept open for site ingress/egress.

**C. Blasting:** Blasting or use of explosives shall not be allowed in any instance.

**D. Disposal of Spoil Material:**

1. Suitable material from excavations which meets the requirements for backfill material as specified in Section 02200, part 3.3.C, except stripping excavation, may be reused. The remaining excavated materials shall be removed from the site and disposed in accordance with all applicable laws, ordinances, and codes per Section 02200.
2. Contractor shall be responsible for the storage, transportation, and deposition of spoiled material, and shall be responsible for acquiring the necessary permits, and the payment of fees and duties, at no additional cost to the Owner.
3. No burning of materials shall be permitted on the site.

#### **3.2 Trench Excavation**

- A** Trenches shall be excavated to the alignment and depth indicated on the Construction Drawings or as necessary for the proper installation of the conduit and appurtenances. Brace and dewater the trench as required and in compliance with Section 3.2.C through E.
- B.** Refer to Section 02200, part 3.2.L for storage of soil materials.
- C.** Refer to Section 02200, part 3.2 for all other excavation requirements.

### 3.3 Trench Subgrade

- A. Excavate the trench to an even grade to permit the installation of the conduit so that the full length of the pipe barrel is supported at the proper depth. The entire foundation sub-grade area in the bottom of the excavations shall be firm, stable material, and the material shall not be disturbed below required grade, except as described in this specification
- B. Remove the material until a firm, stable and uniform bearing surface is reached. Bring the sub-grade brought back to the required grade with the specified bedding material compacted in place or with lean concrete material. The expense of replacing any unsatisfactory sub grade shall be borne by the Contractor.
- C. Should any part of the trench be excavated below required grade, correct the trench with bedding material, thoroughly compacted, or with lean concrete, at no additional compensation to the Contractor.
- D. If local conditions permit reuse, keep surface material suitable for reuse separate from the general excavation material.
- E. The use of any suitable trench digging machinery is permitted except in places indicated on the Construction Drawings, or where such operations may cause damage, above or below ground, in which case, employ hand methods. In pavement areas, trench shall be wide enough to allow the use of compaction equipment.

### 3.4 Backfill

- A. **General:**
  - 1. Prior to backfilling, the owners/operators of existing facilities/utilities that were exposed during potholing or excavation shall be contacted and given the opportunity to inspect for damage that may have occurred during the excavation process. All responses and inspections shall be documented.
  - 2. For Backfill Material see Section 02200, part 3.3.C.
  - 3. The Contractor shall take care not to damage existing facilities and utilities during backfill and compaction.
  - 4. All material used to backfill potholed or excavated existing utilities shall be clean and free of large rocks, sharp objects, and large chunks of hard-packed dirt or clay. The requirements for backfill may be found in FAA-C-1391, Installation and Splicing of Underground Cables. The utility owner/operators shall be contacted for additional requirements regarding their utilities.
- B. **Bedding Placement:** Before installation of conduit, place a bedding of sand per construction drawings and Florida Department of Transportation specifications. Carefully compact material under pipe haunches and bring backfill along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- C. **Fill Placement:** After installation and testing of conduit and cable, place and compact initial backfill of satisfactory soil material or subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit. Carefully compact material



and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

- D. **Moisture Control:** For Moisture Control see Section 02200, part 3.3.D.
- E. **Compaction Requirements:**
1. Compact earth fill and cohesive aggregate fill in accordance with Section 02200 paragraph 3.3.E. Backfill material shall be free of particles larger than 1-inch to a height of 12-inches over utility pipe or conduit.
  2. Compact cohesionless aggregate fill in accordance with Section 02200 paragraph 3.3.E.
  3. The acceptability of the compaction equipment shall be based upon the results of a test section.
  4. Compact earth fill and cohesive aggregate fill to a minimum of 95% of maximum dry density as determined by ASTM D-698, Standard Proctor or ASTM D-1557, Standard Proctor by using nuclear methods.
  5. Compact cohesionless aggregate fill on which it is not practical to control the density by "Proctor" methods to a minimum of 75% of relative density as determined by ASTM D-4253 and D-4254, by a field compaction mold method correlated to ASTM D-4253 and D-4254. Compact cohesionless aggregate fill at a moisture content within a range that accommodates consistent placement and compaction to the minimum relative density specified above.
- F. **Distribution:** Place backfill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.
- G. **Restoration:** Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

### 3.5 **Conduit Installation**

- A. **General Conduit Installation Requirements:**
1. Install conduits at the depths shown on the Construction Drawings and in accordance with Section 16119. If elevations are not shown, conduits shall be installed with cover adequate to resist construction loads.
  2. Changes in Line and Grade. In the event obstructions not shown on the plans are encountered during the progress of the work which will require alterations to the plans, the FAA shall have the authority to change the plans and order the necessary deviation from the line or grade. The Contractor shall not make any deviation from the specified line and grade without approval by the FAA. Should any deviations in line and grade be permitted by the FAA in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, any additional costs shall be borne by the Contractor. Changes in line and grade shall be noted on the as-built drawings.
  3. The Contractor shall place sections of the conduit in the trench without damage and shall properly install the conduit. The sections of conduit shall be fitted together correctly and shall be laid true to line and grade.
    - a. No conduit shall be laid which is damaged, cracked, checked or spalled, or has any other defect deemed by the FAA to make it unacceptable. All such sections shall be permanently removed from the work.
  4. The Contractor shall install warning tape on all conduits as shown on the Construction Drawings.

5. The Contractor shall provide "As-Built" drawings indicating constructed locations and elevations for all installed conduit.

- 3.6 **Finishing:** Refer to Section 02940 for final sodding for stabilization.
- 3.7 **Field Quality Control:** Refer to Section 02200, paragraph 3.3.I.
- 3.8 **Clean and Adjust:** Remove surplus conduit materials, tools, rubbish and temporary structures and leave the construction site clean.

**END OF SECTION**



**SECTION 02450**  
**PRECAST PRESTRESSED CONCRETE PILING**

**PART 1 - GENERAL**

**1.1 SCOPE OF WORK**

This section covers requirements for the manufacture, delivery, and installation of precast prestressed concrete piling as indicated on the plans and as specified herein.

**1.2 RELATED WORK COVERED ELSEWHERE**

Earthwork	Section 02200
Cast In Place Concrete	Section 03301

**1.3 STANDARDS AND CODES**

In addition to all applicable codes, the following codes and standards shall apply, except as may be modified herein:

- 1.3.1 "Uniform Building Code," latest edition.
- 1.3.2 ACI 211.1, "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete," latest edition.
- 1.3.3 ACI 214, "Recommended Practice for Evaluation of Strength Test Results of Concrete," latest edition.
- 1.3.4 ACI 318, "Building Code Requirements for Structural Concrete," latest edition.
- 1.3.5 AWS D1.4, "Structural Welding Code," latest edition.
- 1.3.6 PCI MNL-116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products," latest edition.
- 1.3.7 "Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling, PCI Committee on Prestressed Piling," latest edition.

**1.4 SUBMITTALS**

Submittals shall be in accordance with general requirements and shall include:

- 1.4.1 Pile order lists, details of equipment and methods proposed for handling and driving piles, and the sequence of construction. Driving of piles shall not commence until the Engineer's review of proposed equipment is complete and an authorization to proceed is given.
- 1.4.2 Manufacturer qualifications, as specified in 1.5.2
- 1.4.3. Provide prestressed concrete piles that are manufactured, cured, and driven in accordance with the requirements of the contract documents. Provide piles full length without splice.

- 1.4.3 Shop drawings showing the number and size of prestressing strands, prestress force, reinforcing, mark numbers, pick point locations, and all other details necessary for manufacturing and handling the prestressed concrete piles. Casting of piles shall not commence until shop drawings are approved by the Engineer.

## 1.5 QUALITY ASSURANCE

- 1.5.1. Driving - It is the Contractor's responsibility to install in an undamaged condition all the piles to the tip elevations on the drawings or to refusal as defined by the Engineer. The Contractor shall select, subject to the approval of the Engineer, the hammer size and cushion type and thickness, and the frequency of replacement of cushions so that piles can be installed without damage.
- 1.5.2. Manufacturer's Qualifications - The precast concrete manufacturing plant shall be certified by the Precast/ Prestressed Concrete Institute (PCI) Plant Certification Program. Manufacturer shall be certified at the time of bidding. Certification shall be in the following product groups and categories: C3 or C4. Written evidence may be required listing experience, plant facilities, quality control procedures, staff, and any other documentation needed to establish adequate qualifications for manufacture of the piles.
- 1.5.3. Testing and Manufacturing Procedures - Fabrication and in-plant testing shall be in general compliance with the applicable provisions of PCI MNL-116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products," latest edition.
- 1.5.4. In-Plant Inspection - In-plant inspection of materials and finished products shall be under the supervision of the Manufacturer's Quality Assurance Manager and shall comply with the provisions of PCI MNL-116 and the Manufacturer's documented quality assurance program.
- 1.5.5. Cracked Piles - The Engineer will reject any pile that becomes cracked in handling to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. The Engineer will not reject any pile for the occasional minor surface hairline cracking caused by shrinkage or tensile stress in the concrete from handling. Do not drive piling with irreparable damage, which is defined as any cracks that extend through the pile cross-sectional area that are, or will be, below ground or water level at the end of driving. Such cracks are normally evidenced by emitting concrete dust during their opening and closing with each hammer blow. Remove and replace broken piles or piles cracked to the extent described above at no expense to the Department. The Engineer will accept cracks less than 0.005 inches which do not extend through the pile. Using approved methods, cut off and splice or build-up to cut-off elevation piles with cracks greater than 0.005 inch at the pile head or above ground or water level, and piles with cracks above ground or water level which extend through the cross-sectional area of the pile. The Engineer, at his discretion, may require correction of pile damage or pile cracks by cutting down the concrete to the plane of sound concrete below the crack and rebuilding it to cut-off elevation, or the Engineer may reject the pile. Extract and replace rejected piles that cannot be repaired, at no expense to the owner. Take appropriate steps to prevent the occurrence of cracking, whether steps to prevent additional cracking by using thicker cushions or reducing the ram stroke length. Revise handling and transporting equipment and procedures as necessary to prevent cracking during handling and transportation.

## 1.6 DELIVERY HANDLING AND STORAGE



- 1.6.1. Piles shall be lifted and supported during manufacturing, storage, transportation and driving operations only at the lifting and supporting locations shown on the shop drawings. All lifting devices shall have a minimum safety factor of three. If stacked in multiple layers during storage and shipment, suitable bunks shall be used between each pile at the support locations, with lifting devices accessible and undamaged.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- 2.1.1 Portland Cement: ASTM C 150, "Standard Specification for Portland Cement." Types I, II, or III cement may be used, provided the C3A content does not exceed 8 percent.
- 2.1.2 Aggregates: ASTM C 33, "Standard Specification for Concrete Aggregates."
- 2.1.3 Water: Clean, potable and free from injurious amounts of oils, acids, alkalis, organic materials, or other substances that may be deleterious to concrete or steel.
- 2.1.4 Admixtures: ASTM C 494, "Standard Specification for Chemical Admixtures for Concrete."
- 2.1.5 Mild Steel Reinforcement: ASTM A 615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement," Grade 60.
- 2.1.6 Wire Spiral Ties: ASTM A 82 "Standard Specification for Steel Wire, Plain, for Concrete Reinforcement," smooth or deformed.
- 2.1.7 Prestressing Strand: ASTM A 416, "Standard Specification for Steel Strand, Uncoated Seven-Wire, for Prestressed Concrete."
- 2.1.8 Driving Tips: ASTM A 36 "Standard Specification for Structural Steel," ungalvanized bearing plate and HP stinger tip. Deformed bar anchors shall comply with ASTM A 496. Welding procedures shall conform to AWS D1.4 and AWS D1.1. Steel Points: ASTM A 27, "Standard Specification for Mild to Medium-Strength Carbon-Steel Casting for General Application," one-piece castings.

### **2.2 CONCRETE MIXTURES**

- 2.2.1 Mix designs shall be developed by the pile Manufacturer using the materials as specified herein. The designs shall comply with the requirements of ACI 318 and shall have been prepared in accordance with ACI 211.1, for the concrete strengths shown on the contract drawings. The mix designs shall be based on materials previously evaluated by the pile Manufacturer using established methods of statistical quality control that conform to ACI 214.

### **2.3 FORMWORK**

- 2.3.1 Provide exterior forms of steel on concrete founded casting beds. Side forms for square piles may have minimum draft adequate for stripping. Interior forms shall be of steel and either the fixed-collapsible or moving-mandrel type capable of maintaining specified dimensional tolerances. Forms must be cleaned and oiled prior to placement of reinforcing.

### **2.4 PLACEMENT OF REINFORCING**



- 2.4.1 Provide exterior forms of steel on concrete founded casting beds. Side forms for square piles may have minimum draft adequate for stripping. Interior forms shall be of steel and either the fixed-collapsible or moving-mandrel type capable of maintaining specified dimensional tolerances. Forms must be cleaned and oiled prior to placement of reinforcing.

## **2.5 PLACEMENT OF CONCRETE**

- 2.5.1 Place concrete continuously and consolidate with high frequency vibration. Strike-off unformed surfaces and apply good float finish.

## **2.6 CURING**

- 2.6.1 Cover forms with moisture-retaining cover and apply heat in uniform manner. Embed thermocouples in piles and connect through central computer to electrically heated test cylinders for constant monitoring of curing temperatures and to insure that test cylinders and piles are heated equally.

## **2.7 STRIPPING AND HANDLING**

- 2.7.1 When a test cylinder made from the concrete pour for the piles involved reaches the minimum release strength specified, detension strands gradually and simultaneously so as to maintain internal stresses uniform across the pile cross sections. Burn strands flush with ends of piles. Handle and transport piles as described in paragraph 1.05 above. Do not drive piles until they have reached both their required 28 day strength and a minimum age of 10 days.

## **2.8 FINISHES**

- 2.8.1 Piles with minor imperfections which do not impair the structural integrity of the pile, such as small surface holes caused by air bubbles, color variations, form joint marks, and minor chips and spalls will be accepted as is. Piles with defects such as honeycomb which could reduce the structural capacity of the pile will be accepted only if repaired to the Engineer's satisfaction.

## **2.10 MANUFACTURING TOLERANCES**

- 2.10.1 Length ..... +6 in., -2 in.
- 2.10.2 Width or diameter .....  $\pm 3/8$  in..
- 2.10.3 Sweep (variation from straight line parallel to centerline of pile) (considered to be a form tolerance) .....  $\pm 1/8$  in. per 10 ft; 1/2" max. - within length of product.
- 2.10.4 Position of tendons .....  $\pm 1/4$  in.
- 2.10.5 Wall thickness ..... -1/4 in., +1/2 in.
- 2.10.6 Position of handling devices ..... +6 in.
- 2.10.7 Position of steel driving tips .....  $\pm 1/2$  in..

2.10.8 Variation from specified end squareness or skew .....  $\pm 1/4$  in. per 12 in.,  $\pm 1/2$  in. max.

2.10.9 Local straightness any surface .....  $\pm 1/4$  in. per 10 ft.

2.10.10 Longitudinal spacing of spiral reinforcement .....  $\pm 3/4$  in.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

3.1.1. Pile Hammers - All equipment is subject to satisfactory field performance. Use a variable energy hammer to drive concrete piles. Hammers will be rated based on the theoretical energy of the ram at impact. Supply driving equipment which provides the required resistance at a blow count ranging from 3 blows per inch (36 blows per foot) to 10 blows per inch (120 blows per foot) at the end of initial drive, unless approved otherwise by the Engineer after satisfactory field trial. When requested, furnish to the Engineer all technical specifications and operating instructions related to hammer equipment.

3.1.1.1. Templates and Ground Elevations - Provide a fixed template, adequate to maintain the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. Where practical, place the template so that the pile can be driven to cut-off elevation before removing the template. Ensure that templates do not restrict the vertical movement of the pile. Supply a stable reference close to the pile, which is satisfactory in the opinion of the Engineer, for determination of the pile penetration. At the time of driving piles, furnish the Engineer with elevations of the original ground and template at each pile or pile group location. Note the highest and lowest elevation at each required location and the ground elevation at all piles.

3.1.2. Penetration Requirements - Measure the penetration of piles from the elevation the bottom of excavation shown in the plans. The Contract Documents show a minimum depth of penetration, drive the tip of the pile to this minimum penetration depth. The Engineer will accept the bearing of a pile only if the Contractor achieves the required bearing when the tip of the pile is at or below the specified minimum depth of penetration.

#### **3.2 METHODS TO DETERMINE PILE CAPACITY**

3.2.1 Dynamic Load Tests - Dynamic load test will be used to confirm the pile capacities. Install instruments on the four (4) selected Dynamic Load Test Piles at the locations indicated in the plans. The Contractor will take dynamic measurements during the driving of these four (4) piles. Test piles will be left in place as permanent piles.

3.2.2 WEAP - Use Wave Equation Analysis for Piles (WEAP) programs to evaluate the suitability of the proposed driving system (including the hammer, follower, capblock and pile cushions) as well as to estimate the driving resistance, in blows per 12 inches or blows per inch, to achieve the pile bearing requirements and to evaluate pile driving stresses.

Use Wave Equation Analyses to show the hammer is capable of driving to a resistance equal to at least 2.0 times the factored design load without overstressing the piling in compression or tension and without reaching practical refusal (20 blows per inch).

Use the wave equation to evaluate the proposed pile cushioning. Use the following equations to determine the maximum allowed pile stresses as predicted by the wave equation, and measured during driving when driving prestressed concrete piling:

$$S_{apc} = 0.7 f'_c - 0.75 f_{pe} \quad (1)$$

$$S_{apt} = 6.5 (f'_c)^{0.5} + 1.05 f_{pe} \quad (2a) \text{ for piles less than 50 feet long}$$

$$S_{apc} = 3.25 (f'_c)^{0.5} + 1.05 f_{pe} \quad (2b) \text{ for piles 50 feet long and greater}$$

Where:

$S_{apc}$  = maximum allowed pile compressive stress, psi

$S_{apt}$  = maximum allowed pile tensile stress, psi

$f'_c$  = specified minimum compressive strength of concrete, psi

$f_{pe}$  = effective prestress (after all losses) at the time of driving, psi, taken as 0.8 times the initial prestress force.

### 3.3 PILE CAP CONNECTION REINFORCEMENT

Construct the top of pile cap connection reinforcement with the details shown in the plans and in a manner including the requirements, sequences, and procedures outlined below:

- (a) Drill dowel holes using an approved steel template that will position and align the drill bit during drilling. Drill holes a minimum of 2 inches deeper than the length of the dowel to be inserted.
- (b) Clean the drilled dowel holes by inserting a high pressure air hose to the bottom of the hole and blowing the hole clean from the bottom upward. Eliminate any oil, dust, water, and other deleterious materials from the holes and the concrete surfaces to be joined.
- (c) Use an epoxy bonding material system to anchor the dowel reinforcement bars in the top of the pile as indicated in the contract plans. Prior to installation, submit the selected epoxy bonding material system to the engineer for review and approval. The material systems shall be specifically intended for use in structural applications for bonding anchors and dowels to hardened concrete. Mix the adhesive components in accordance with the manufacturer's directions. Do not mix sand or any other filler material with the epoxy components unless it is prepackaged by the manufacturer for this specific purpose. Do not use material from containers which are damaged or have been previously opened. Use only full packages of components. Combining of epoxy bonding components from bulk supplies is not permitted.
- (d) After ensuring that all concrete surfaces are dry, fill the dowel holes with the adhesive material.
- (e) Insert the dowels into the adhesive filled holes of the pile section and position such that the axes of the dowels bars and pile are in concentric alignment. Ensure the holes are filled completely with the adhesive.

END OF SECTION



**SECTION 02940**  
**GRASSING (BY SODDING)**

**PART 1 - GENERAL**

- 1.1 **Scope:** The Contractor shall furnish all labor, materials, tools, equipment, plant, and services necessary to restore to original conditions all of the areas disturbed by construction efforts. These include areas where Contractor is directed to sod whether or not disturbed by construction. These areas are not only immediately adjacent to active construction, but can be any area utilized by Contractor (including areas traversed) that has been defaced during the contract.
- 1.2 **Conditions:** Sod shall be placed only when the soil is moist and in proper condition to induce growth. Fertilizing, sodding, or other planting operations will not be permitted when wind velocities exceed 15 miles per hour. When drought, water saturated soil, freezing temperatures, or inclement weather conditions prevail, the work shall be postponed.
- 1.3 **Maintenance And Repair:** The Contractor shall maintain sodded areas until final acceptance of the work is made as specified in the contract. This includes watering as needed to ensure successful rooting and growth of the sod.
- 1.4 **Submittals:** Certification of compliance with the specifications from the material supplier for sod, fertilizer, and lime.

**PART 2 - PRODUCTS**

- 2.1 **Fertilizer:** The numerical designations for fertilizer indicate the minimum percentages (respectively) of (1) total nitrogen, (2) available phosphoric acid, and (3) water soluble potash contained in the fertilizer. Contractor shall supply any commercially recognized brand of 10-10-10 fertilizer, unless otherwise directed, or as prescribed by local and/or State regulations which may restrict rate or time of fertilizer application. At least 50% (percent) of the phosphoric acid shall be from normal super phosphate or an equivalent source that will provide a minimum of 2 units of sulfur. The amount of sulfur shall be indicated on the quantitative analysis card attached to each bag or other container.
- 2.2 **Lime:** The designation "fertilizing" shall include the application of an agricultural type, dolomitic limestone where indicated for by soil testing or direction of the FAA. The limestone may be a component of the 10-10-10 fertilizer or may be separately applied.
- 2.3 **Sod:** Sod shall be well matted with roots. Grass species shall be in accordance with plans. When not specified on the plans, sod shall be bahia grass. Sod shall be provided in commercial size rectangles or rolls, and a minimum of 1.25 inches thick, including a ¾ inch layer of root/topsoil. Any netting that may be included with sod shall be certified by the manufacturer/Contractor to be biodegradable within three months of installation. Sod shall be free of nuisance/exotic species of grass/weeds.
- 2.4 **Water:** Fresh and free of substances harmful to seed germination.

**PART 3 - EXECUTION**

- 3.1 **Preparation Of Area To Be Sodded:** The ground over which the sod is to be placed shall be prepared by disc harrowing, and thoroughly pulverizing the soil to a depth of 6". Harrowing/loosening may be eliminated in areas where the FAA finds that the soil bed is sufficiently loose. Apply soil amendments as

needed to support sod rooting and growth. Apply stockpiled topsoil if required by plans. The prepared soil shall be loose and reasonably smooth. It shall be free of clods, roots, concrete, rocks, and discarded construction, or other deleterious materials that will interfere with the work or subsequent mowing and maintenance operations. Thoroughly water the area to be sodded and allow water to percolate into the soil prior to sodding. Do not sod on muddy soil conditions. The FAA shall be given 72 hours advance notice to inspect the area before any application of fertilizer or sod commences.

- 3.2 Preplanting Fertilization:** The fertilizer and/or lime shall be spread uniformly over the area to be grassed. The lime shall be spread at a rate of 1200 pounds per acre, unless otherwise called for by testing.

Immediately after the fertilizer and/or lime is spread over the prepared soil it shall be mixed into the soil to a depth of approximately 4".

Straight fertilizer shall be applied in one or more applications as specified below unless otherwise called for in plans or by direction of the FAA:

- (a) An initial application of 1200 pounds per acre.
- (b) Approximately 60 calendar days after the initial application, and on projects which have not yet been accepted; unless otherwise directed, subsequent applications of 1200 pounds per acre shall be applied by mixing into the soil.

- 3.3 Sodding:** Do not use sod that has been cut for more than 72 hours. Stack sod that is not used within 24 hours. Pre-wet area prior to placing sod. Do not sod on muddy or eroded surfaces. While the soil is still loose, sod shall be placed over the grassing area as called for in plans. Abut sides and ends tightly. Ensure contact of the sod with the prepared soil. In drainage ditches, swales, or other areas where water may flow, stagger sod joints. Stake or pin where indicated in plans or where slopes exceed 4:1 (horizontal : vertical). Do not leave pins/stakes above grade. Tamp outer limits of sod to result in a feathered edge effect.

- 3.4** Not used.

- 3.5** Not used.

- 3.6 Rolling:** Immediately after completion of the sodding, the entire sodded area shall be rolled thoroughly with a light weight turf roller. A sufficient number of passes shall be used to ensure contact of the sod with the prepared soil.

- 3.7 Watering:** Thoroughly water newly sodded areas immediately. Sodded areas are to be watered to sustain grass growth. The Contractor shall provide water supplies, and equipment that can uniformly distribute water in a manner that will not disturb the sod nor cause erosion.

- 3.8 Maintenance and Repair:** Maintenance shall consist of watering and mowing operations and protecting such areas from traffic. The Contractor shall mow the grassed area as necessary to prevent the establishment of a wildlife attractant condition, and to maintain aesthetic appearance. Repair shall consist of re-establishing sod areas damaged by traffic, erosion, drought, fire, run-off from watering or rain, or standing water. Such areas shall be re-sodded in accordance with this specification until a 95% (percent) covering of the area by mature, well-rooted grass is achieved.

#### END OF SECTION



**SECTION 03301**  
**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

- 1.1 **Scope:** This Section specifies cast-in-place concrete and precast concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- 1.2 **Codes and Standards:** Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified.
1. ACI 318, "Building Code Requirements for Reinforced Concrete".
  2. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".
- 1.3 **Submittals** - Submit mix design for all classes of concrete, and all laboratory or field tests performed in accordance with Paragraph 3.14.

**PART 2 - PRODUCTS**

- 2.1 **Form Materials**
- A. **Forms for Exposed Finish Concrete:** Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in large practicable sizes to minimize number of joints and to conform to joint system shown on the drawings.
  - B. **Forms for Unexposed Finish Concrete:** Provide plywood, lumber, metal, or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit.
- 2.2 **Plywood Forms:** Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, exterior grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- 2.3 **Forms Coatings:** Provide commercial form coating that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- 2.4 **Form Ties:** Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.
- 2.5 **Reinforcing Materials**
- A. **Reinforcing Bars:** ASTM A 615, Grade 60, deformed, except A307 for bars to be welded. Detailed and fabricated in accordance with ACI 315.
  - B. **Welded Wire Fabric:** ASTM A 185, welded steel wire fabric.
  - C. **Supports for Reinforcement:** Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type supports complying with CRSI specifications.
    1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
    2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).



## 2.6 Concrete Materials

- A. **Portland Cement:** ASTM C 150, Type I. Use one brand of cement throughout project.
- B. **Fly Ash:** ASTM C 618, Type C or Type F.
- C. **Normal Weight Aggregates:** ASTM C 33 and as herein specified. Provide aggregates from a single source for exposed concrete.
  - 1. Do not use fine or coarse aggregates containing deleterious substances that cause spalling.
  - 2. Local aggregates not complying with ASTM C 33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to AGENT.
- D. **Water:** Potable.
- E. **Admixture, General:** Provide admixtures for concrete that contain not more than 0.1 percent chloride ions.
  - 1. Air-Entraining Admixtures - ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 2. Water Reducing Admixture - ASTM C 494, Type A.
  - 3. High-Range Water-Reducing Admixture (Superplasticizer) - ASTM C 494, Type F or Type G.
  - 4. Water-Reducing, Accelerating Admixture - ASTM C 494, Type E.
  - 5. Water-Reducing, Retarding Admixture - ASTM C 494, Type D.

## 2.7 Related Materials

- A. **Vapor Retarder:** Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows: Polyethylene sheet - not less than 8 mils thick.
- B. **Absorptive Cover:** Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- C. **Moisture-Retaining Cover:** - One of the following, complying with ASTM C 171.
  - a. Waterproof paper.
  - b. Polyethylene film.
  - c. Polyethylene-coated burlap.
- D. **Liquid Membrane-Forming Curing Compound:** Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq.cm. when applied at 200 sq.ft./gal.
- E. **Evaporation Control:** Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

## PART 3 - EXECUTION

- 3.1 **General:** Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.
- 3.2 **Forms**
  - A. **General:** Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct

formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347. Construct forms to sizes, shapes, lines and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, molding, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

- B. **Fabrication:** Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- C. **Temporary Openings:** Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- D. **Chamfer:** Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- E. **Provisions for Other Trades:** Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- F. **Cleaning and Tightening:** Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

### 3.3 **Vapor Retarder/Barrier Installation**

- A. Following leveling and tamping of base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal vapor barrier joints with manufacturer's recommended mastic and pressure-sensitive tape.
- C. After placement of vapor retarder/barrier, cover with sand cushion and compact to depth as shown on drawings.

### 3.4 **Placement of Reinforcement**

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcement Bars," for details and methods of reinforcement placement and supports and as herein specified.
- B. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.



- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by AGENT.
- E. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not towards exposed concrete surfaces. Lap distance shall be in accordance with ACI 315. Minimum lap of a bar is 24 times bar diameter.
- F. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous line of lap in either direction.

### 3.5 Preparation of Form Surfaces

- A. Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed.
- B. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

### 3.6 Proportioning and Design of Mixes

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 211.1 and batched in accordance with ACI 304.
- B. Limit use of fly ash to not exceed 25 percent of cement content by weight. Fly ash is not to be used where high early strength is specified.
- C. Contractor shall design mixes to provide normal weight concrete with the following properties, or as indicated on drawings and schedules: 3000-psi, 28-day compressive strength; W/C ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained). High early strength concrete shall be used for concrete that is to be placed within the runway safety area. It shall have minimum cement content of 800 pounds per cubic yard and a maximum water-cement ratio of 0.43. High early strength concrete shall attain a minimum flexural strength of 675 psi in 24 hours, which shall be obtained prior to opening the runway for operations. Course aggregate may be any one of the following sizes: No. 57, No. 6, No. 67, or No. 8. When No. 8 size is used, the entrained air content shall be 8 +/- 2 percent. Otherwise, the entrained air shall be 6 +/- 2 percent. The AGENT's approval of the concrete mix design will be based on the Contractor's submitted proportions and the foregoing information.
- D. Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by AGENT. Laboratory test data for revised mix design and strength results must be submitted to and accepted by AGENT before using.
- E. Admixtures
  - 1. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.
  - 2. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
  - 3. Use high-range water-reducing admixture (HRWR) in pumped concrete, architectural concrete, concrete required to be watertight, and concrete with water/cement ratios below 0.50.



4. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within following limits:
  - a. Concrete structures and slabs exposed to freezing and thawing - 4.5 percent (moderate exposure) 1-1/2-inch max. aggregate.
  - b. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to receive a surface hardener: 2 percent to 4 percent air.
5. Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.

**E. Slump Limits:** Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, Slabs, and Sloping Surfaces - Not more than 3-inches.
2. Reinforced Foundation Systems - Not less than 1-inch and not more than 3- inches.
3. Concrete Containing HRWR Admixture (Superplasticizer) - Not more than 8 inches after addition to HRWR to site-verified 2-inch to 3-inch slump concrete.
4. Other Concrete - Not more than 4-inches.

**3.7 Ready-Mix concrete**

- A. Ready-Mix Concrete shall comply with requirements of ASTM C 94, and as specified.
- B. Provide to the AGENT batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- C. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

**3.8 Concrete Placement**

- A. **General:** Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
- B. **Inspection:** Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.
- C. **Placing Concrete in Forms:** Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.
  1. Consolidate placed concrete primarily by mechanical vibrating equipment, supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
  2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6-inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

- D. **Placing Concrete Slabs:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. The use of added water or other medium to increase surface water in conjunction with use of a float or darbie is not permitted. Do not disturb slab surfaces prior to beginning finishing operations.
  3. Maintain reinforcing in proper position during concrete placement.
- E. **Cold-Weather Placing:** Comply with provisions of ACI 306 and as follows.
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  2. When air temperature has fallen to or is expected to fall below 40 deg f (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  4. Do not use calcium chloride salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- F. **Hot-Weather Placing:** When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg f (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
  2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
  3. Fog-spray forms, reinforcing steel, and subgrade just before concrete is placed.
  4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions.

### 3.9 **Finish of Formed Surfaces**

- A. **Rough Form Finish:** For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.
- B. **Smooth Form Finish:** For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. **Related Unformed Finish:** At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless other wise indicated.

### 3.10 **Monolithic Slab Finishes**



- A. **Scratch Finish:** - Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 15 and floor levelness (F1) of 13. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- B. **Trowel Finish:** Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 20 - Ff 17. Grind smooth surface defects that would telegraph through applied floor covering system.
- C. **Trowel and Fine Broom Finish:** Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

### 3.11 **Concrete Curing And Protection**

- A. **General:** Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. **Initial Curing:** Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. **Curing Methods:** Perform curing of concrete by moist curing, or by moisture-retaining cover curing, or by curing and sealing compound, or by combinations thereof, as herein specified.
  - 1. **Moist Curing**
    - a. Keep concrete surface continuously wet by covering with water; or
    - b. Use continuous water-fog spray; or
    - c. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
  - 2. **Moisture-Retaining Cover Curing:** Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during period using cover material and waterproof tape.
  - 3. **Curing and Sealing Compounds:** Apply curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- D. **Curing Formed Surfaces:** Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.



E. **Curing Unformed Surfaces:** Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

F. **Treated Surfaces:** Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

**3.12 Removal of Forms:** Formwork not supporting weight of concrete, such as walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

**3.13 Concrete Surface Repairs**

A. Repair and patch defective areas with cement mortar immediately after removal of forms.

B. Cut out honeycomb, rock pockets, voids over 1/4-inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.

C. **For Exposed-to-View Surfaces:** Blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

D. **Repair of Formed Surfaces:** Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of AGENT. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discoloration's that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar.

1. **Concealed Formed Surfaces:** Where possible, repair defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

E. **Repair of Unformed Surfaces:** Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to AGENT.

4. Repair defective areas, except random cracks and single holes not exceeding 1-inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

**3.14 Quality Control Testing During Construction**

- A. **General:** The Contractor will employ a testing laboratory to perform tests and to submit test reports. Sampling and testing for quality control during placement of concrete shall include the following.
- B. **Sampling Fresh Concrete:** ASTM C 172, except modified slump to comply with ASTM C 94.
1. **Slump:** ASTM C 143; one test at point of discharge for each day's placement of each type of concrete; additional tests when AGENT determines that concrete consistency appears to have changed.
  2. **Air Content** - One for each day's placement of each type of air-entrained concrete (ASTM C 173, volumetric method for light weight concrete; ASTM C 231 pressure method for normal weight concrete).
  3. **Concrete Temperature:** Test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and each time a set of compression test specimens is made.
  4. **Compression Test Specimen:** ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
  5. **Compression Strength Tests:** ASTM C 39; one set for each day's placement not exceeding 5 CY, plus additional sets for each 50 CY more than the first 25 CY of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- C. **Test Results:** Test results will be reported in writing to AGENT, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. **Standards:** Strength level of concrete will be considered satisfactory if averages of sets of three consecutive 28-day strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
1. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
- E. **Additional Tests:** The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by AGENT. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

**END OF SECTION**



**SECTION 05120**  
**STRUCTURAL STEEL**

**PART 1 - GENERAL**

**1.1**     **Work Included:** Provide fabrication and erection of structural steel and other items as shown on the drawings or required by other divisions of these specifications. Provide inspector to inspect bolts and welds during steel erection.

**1.2**     **Applicable Publications:** Industry publications controlling the work of this division include:

**A.**        **American Institute of Steel Construction (AISC):**

Manual of Steel Construction, Allowable Stress Design (ASD).

**B.**        **American Society for Testing and Materials (ASTM):**

ASTM A36-90                      Structural Steel.

ASTM A53-90a                    Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless.

ASTM A108-90a   Steel Bars, Carbon, Cold Finished, Standard Quality.

ASTM A123-89a   Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A307-90                  Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

ASTM A325-90                  High-Strength Bolts for Structural Steel Joints.

ASTM A490-90                  Heat-Treated, Structural Steel Bolts, 150 (KSI) (1035MPa) Tensile Strength.

ASTM A500-90                  Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A563-90                  Carbon and Alloy Steel Nuts.

ASTM A780-80                  Standard Practice for Repair of Damaged Hot-Dip Galvanized Coatings.

ASTM B695-91                  Coatings of Zinc Mechanically Deposited on Iron and Steel.

ASTM F436-90                  Hardened Steel Washers.

ASTM F959-90                  Compressible-Washer-Type Direct Tension Indicator for Use with Structural Fasteners.

**C.**        **American Welding Society (AWS):**

AWS A5.1:                      Covered Carbon Steel Arc Welding Electrodes.

AWS A5.5:                      Low Alloy Steel Covered Arc Welding Electrodes.



AWS C2.2-67: Recommended Practices for Metalizing with Aluminum and Zinc for Protection of Iron and Steel.

AWS D1.1: Structural Welding Code - Steel.

**D. Research Council on Structural Connections (RCSC):**

"Specifications for Structural Joints Using ASTM A325 Bolts or ASTM A490 Bolts," as endorsed by AISC.

**E. Steel Structures Painting Council (SSPC):**

SSPC-SP3: Power Tool Cleaning.

SSPC-Paint 11: Red Iron Oxide, Zinc Chromate, Raw Linseed Oil and Alkyd Paint.

**1.3 Submittals:** Submit Fabrication and erection drawings showing all details, connections, material designations, and all top of steel elevations.

**1.4 Quality Assurance:** Welders shall be qualified as prescribed in AWS D1.1.

**PART 2 - PRODUCTS**

**2.1 Structural Steel** - Structural shapes, plates, bars, tubing and steel pipe shall conform to the following specifications:

**A. Shapes, plates and bars:** conform to ASTM A36.

**B. Structural tubing:** conform to ASTM A500, Grade B.

**C. Steel pipe:** conform to ASTM A53, Type E or S, Grade B.

**2.2 Anchor Bolts:** conform to ASTM A307 with heavy hexagonal nuts.

**2.3 Bolts:** Bolts shall be in accordance with the following:

**A.** Common (machine) bolts shall conform to ASTM A307 Grade A and nuts to ASTM A563. One common bolt assembly shall consist of a bolt, a heavy hex nut, a lock nut and a hardened washer.

**B.** High strength bolts shall conform to ASTM A325. One high strength bolt assembly shall consist of a heavy hex head structural bolt, a heavy hex nut, a hardened washer conforming with ASTM F436 and a direct tension indicator conforming with ASTM F959. The hardened washer shall be installed against the element turned in tightening.

**2.4 Welding Electrodes:** Welding electrodes shall comply with AWS D1.1 using AWS A5.1 or AWS A5.5 E70XX and shall be compatible with the welding process selected.

**2.5 Headed Welded Studs:** Headed welded studs shall be manufactured of cold rolled steel conforming to ASTM A108. Yield strength shall be 50,000 psi minimum; ultimate tensile strength shall be 60,000 psi minimum.

**2.6 Locknut:** For use with other than high strength bolts.

- A. **Alternate 1:** "Palnuts" as manufactured by Palnut Company of Irvington, NJ, or approved equal.
- B. **Alternate 2:** "Anco Lock Nut" as manufactured by Automatic Nut Co. of Lebanon, PA, or approved equal, in lieu of the regular hex nut and the locknut.

2.7 **Primer:** Primer shall be a red oxide-chromate primer complying with SSPC Paint Specification No. 11.

### **PART 3 - EXECUTION**

3.1 **Fabrication:** Shop fabricate and assemble materials as specified herein.

- 3.1.1 Fabricate items of structural steel in accordance with the AISC-ASD Specifications, and as indicated on the approved shop drawings.
- 3.1.2 Properly mark and match-mark materials for field assembly and for identification as to location for which intended.
- 3.1.3 Fabricate and deliver in a sequence which will expedite erection and minimize field handling of materials.
- 3.1.4 Where finishing is required, complete the assembly, including welding of units, before start of finishing operations.
- 3.1.5 Provide finish surfaces of members exposed in the final structure free from markings, burrs, and other defects.
- 3.1.6 Provide connections as specified herein.
  - 3.1.6.1 Provide bolts and washers of types and sizes required for completion of field erection.
  - 3.1.6.2 Install high strength threaded fasteners in accordance with RCSC "Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts."
  - 3.1.6.3 Welded construction shall comply with AWS D1.1 for procedures, appearance, quality of welds, and methods used in correcting welded work.
  - 3.1.6.4 Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.
  - 3.1.6.5 All connections which are not detailed or otherwise noted on the design drawings shall be shop welded and field bolted in accordance with AISC Framed Beam Connections, Tables II and III as shown in the AISC-ASD Manual of Steel Construction. Use the maximum number (n) rows of field bolts compatible with a beam T dimension and flange cope for each beam depth under consideration. Use a 1/4-inch shop weld "A" shown in Table III for the required number of field bolts. All bolted connections shall be designed for the full capacity of the connecting members.
  - 3.1.6.6 The fabricator shall furnish and install erection clips for fit-up of welded connections.
  - 3.1.6.7 Double angle members shall have welded fillers spaced in accordance with Chapter E4 of the AISC-ASD Specification.

- 3.2     Plates:** Gusset and stiffener plates shall be 3/8-inch thick minimum.
- 3.3     Columns:** Columns shall have full bearing at splices and at end plates.
- 3.4     Camber:** All members shall be fabricated with natural camber up.
- 3.5     Shop Priming:** Structural steel shall be shop primed as specified herein, unless shown otherwise on the drawings.
- 3.5.1**     Structural steel surface preparation shall conform to SSPC-SP3, "Power Tool Cleaning."
- 3.5.2**     Surface preparation and primer application shall be in accordance with AISC Code of Standard Practice as included in the ASD Manual of Steel Construction.
- 3.5.3**     Storing, thinning, mixing, handling, and application of paint materials shall be in accordance with manufacturer's instructions. Containers shall remain closed until required for use. Manufacturer's pot-life requirements shall be strictly adhered to.
- 3.5.4**     Primer shall be applied to dry, clean, prepared surfaces and under favorable conditions in accordance with manufacturer's instructions. Unless otherwise recommended by manufacturer, priming shall not be done when the ambient temperature is less than 50°F, the relative humidity is more than 90 percent, or the surface temperature is less than 5°F above the dew point.
- 3.5.5**     Generally, all primer shall be spray applied. Brush or roller application shall be restricted to touch-up and to areas not accessible by spray gun.
- 3.5.6**     Primer shall be uniformly applied without runs, sags, solvent blisters, dry spray or other blemishes. All blemishes and other irregularities shall be repaired or removed and the area recoated. Special attention shall be paid to crevices, weld lines, bolt heads, corners, edges, etc., to obtain the required nominal film thickness.
- 3.5.7**     The dry film thickness of the primer shall be 2.0 mils.
- 3.5.8**     If primer is damaged by welding or physical abuse, the area shall be touched-up and repaired. The touch-up paint shall be compatible with the applied primer with minimum dry film thickness of 1.5 mils.
- 3.5.9**     All primers and touch-up paint shall be applied in strict accordance with the manufacturer's instructions and these specifications.
- 3.6     Galvanizing:** All galvanizing shall be as specified herein.
- 3.6.1**     When indicated on the drawings, structural steel including handrail, ladder, stairway, treads, grating, checkered plate, bolts, nuts and washers shall be galvanized in accordance with this Section and the applicable ASTM Standards.
- 3.6.2**     Galvanizing of structural steel shapes, plates, bars and strips shall be in accordance with ASTM A123. Minimum weight of zinc coating shall be 2.0 oz/ft<sup>2</sup> for individual specimen and minimum thickness of 3.4 mils.
- 3.6.3**     When specified on drawings, all bolts, nuts and washers shall be mechanically zinc coated in accordance with ASTM B695, Type I. Nuts shall be tapped oversize in accordance with ASTM A563 prior to zinc coating and need not be retapped after coating.



- 3.6.4** The fabricator shall be responsible to safeguard against embrittlement and warpage.
- 3.6.5** Whenever practical, cutting, drilling and welding shall be performed prior to galvanizing.
- 3.7** **Erection:** Erection of structural steel shall be as specified herein.
- 3.7.1** Erection of structural steel shall comply with AISC "Code of Standard Practice."
- 3.7.2** Structural field welding shall be done by the electric submerged or shielded metal arc process. Welded construction shall comply with AWS D1.1.
- 3.7.3** Headed welded studs shall be automatically end welded in accordance with the manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and the plate. There shall be no porosity or evidence of lack of fusion between the welded end of the stud and the plate. The stud shall decrease in length during welding approximately 1/8-inch for studs 5/8-inch diameter and under, and 3/16-inch for studs over 5/8-inch diameter.
- 3.7.4** Provide anchor bolts and other connectors required for securing structural steel to foundations and other in-place work. Provide templates and other devices necessary for presetting bolts and anchors to accurate locations.
- 3.7.5** Splice members only where indicated on the drawings.
- 3.7.6** Gas cutting torches shall not be used for correcting fabricating errors in the structural framing. Gas cutting is permitted only in secondary members. Finish gas cut sections to a sheared appearance.
- 3.7.8** Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Provide temporary guy lines to achieve proper alignments of the structure as erection proceeds. Remove temporary connections and members when permanent members are in place and the final connections have been made.
- 3.7.9** Provide and set bases and bearing plates as specified herein. Clean concrete bearing surfaces free from bond-reducing materials, and then roughen to improve bond to the surface. Clean the bottom surface of base and bearing plates. Set loose and attached base plates and bearing plates for structural members in wedges or other adjusting devices. Tighten anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout. Dry pack grout solidly between bearing surfaces and bases or plates to assure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure in strict compliance with the manufacturer's recommendations.
- 3.7.10** Set structural frames accurately to the lines and elevations indicated.
- 3.7.11** Align and adjust members forming part of a complete frame or structure before fastening permanently.
- 3.7.12** Clean bearing surfaces, and other surfaces which will be in permanent contact, before assembly.
- 3.7.13** Level and plumb individual members of the structure within AISC tolerances in accordance with the AISC Code of Standard Practice as included in the ASD Manual of Steel Construction.

- 3.7.15** Establish required leveling and plumbing measurements on the mean operating temperature of the structure, making allowances for the difference between temperature at time of erection and the mean temperature at which the structure will be when completed and in service.
- 3.7.16** Install and fully tension high strength threaded fasteners in accordance with RCSC, "Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts."
- 3.8** **Repairing Damaged Hot-Dip Galvanized Coatings:** When approved by the WRPE Designee, hot-dip galvanized coatings shall be repaired as follows:
- 3.8.1** All damaged hot-dip galvanized coatings of reamed or field-drilled holes shall be repaired using a zinc-rich paint.
- 3.8.1.1** As a minimum, the zinc-rich paint dried film shall contain 94% zinc dust by weight, and shall conform to ASTM A780-80.
- 3.8.1.2** Minimum dry film thickness is 3 mils.
- 3.8.1.3** Acceptable products include Z.R.C. liquid cold galvanizing compound with shiny finish, by ZRC Products Company, or previously approved alternate.
- 3.8.2** All other damaged galvanized coatings shall be repaired using a metalizing/thermal spray coating process per AWS C2.2-67.
- 3.8.2.1** Use a metalizing alloy composed of 85% zinc and 15% aluminum.
- 3.8.2.2** Minimum coat thickness shall be 6 mils. Dry film thickness shall be measured by using a magnetic or electromagnetic gage. Measurements shall be taken in the presence of the WRPE Designee at locations selected by him.
- 3.8.3** **Surface Preparation:**
- 3.8.3.1** Surfaces to be reconditioned shall be clean, dry, and free of oil, grease, and corrosive products.
- 3.8.3.2** Surface preparation shall be in accordance with ASTM A870 and AWS C2.2-67.
- 3.8.3.3** To ensure a smooth coating, surface preparation shall extend into the undamaged galvanized coating. The method and extent of surface preparation shall be approved by the WRPE Designee.

**END OF SECTION**

**SECTION 05121**  
**STRUCTURAL STEEL ERECTION**

**PART 1 - GENERAL**

- 1.1     Work Included:** Furnish all labor and materials, equipment and incidentals necessary to erect structural steel and miscellaneous metals.

**1.2     Related Work Covered Elsewhere:**

Cast-in-Place Concrete	Section 03301
Structural Steel	Section 05120
Miscellaneous Metals	Section 05500
Painting	Section 09900

**1.3     QUALITY ASSURANCE:**

**A.     Testing:**

1. All shop welds shall be visually inspected and physically tested. Full penetration shop and field welds shall be non-destructive tested by radiographic, ultrasonic, magnetic particle or dye penetrant methods in accordance with AWS B1.10 as approved by the Subcontract Administrator. Tubular constructions shall be inspected by ultrasonic methods, Class R. All test methods and procedures used shall be determined by the WRPE Designee in advance of welding.
2. Welding shall be inspected by an independent testing agency selected by the Subcontract Administrator and whose services shall be paid by the Government. The testing agency is the representative of the Government and the Subcontractor shall make all facilities available for inspection at all times, including Shop Fabrication. Inspection of welding shall be in conformance with AWS D1.1 "Structural Welding Code Steel".
3. High Strength Bolts in connections shall be inspected by Governments testing agency in accordance with AISC "Specification for Structural Joints using ASTM A-325 or A-490 Bolts". Records shall be kept for all testing and shall show date of inspection, location and type of weld, defects encountered and date of repairs.

- B.     Re-inspection:** Subcontractor shall bear costs of re-inspection due to specification non-conformance discovered during tests.

**C.     Welder's Qualification:**

1. Welds shall be made only by operators who have previously qualified by tests, as prescribed by the "Standard Qualification Procedure" in the "Structural Welding Code - Steel" by the American Welding Society to perform the type of work required. The Subcontractor shall provide certification that welders have passed qualification test within six months just prior to performance of work.
2. The techniques of welding employed, the appearance and quality of welds made, and methods used in correcting defective work shall conform to Section 4, "Technique" of the Current Edition of the "Structural Welding Code - Steel" by the American Welding Society.

**1.4     Submittals:**

Submittals shall be in accordance with general requirements and shall include the following:

- A.**     Certificate of Welder's qualification
- B.**     Schedule of Time Schedule for Shop fabrication



- C. Erection Schedule and Description of Erection Procedures
- D. Setting Bolt and Anchor Plate Templates.

**1.5 References and Standards:**

The applicable provisions of the following references and standards are hereby made a part of this Section as if written herein in their entirety:

- A. **American Institute of Steel Construction (AISC) Publications:** "Specifications for Structural Steel Buildings"
- B. **Steel Joist Institute (SJI):** "Standard Specifications", Sections 5 and 6.
- C. **American Welding Society (AWS) Publication:** "Code for Arc and Gas Welding in Building Construction"

AWS D1.1	Structural Welding Code - Steel
AWS B1.10	Guide for Non-Destructive Inspection of Welds
AWS A5.1	Specification for Covered Carbon Steel Arc Welding Electrodes
AWS A5.5	Specification for Low Alloy Steel Covered Arc Welding Electrodes

- D. **Military Specification:** MIL-P-21035, High Zinc Dust Content, Galvanizing Repair.

**1.6 Delivery, Handling, and Storage:** Deliver steel members and fabricated components to site and store on wood runners or platform raised above grade level. Steel shall not come into contact with groundwater.

**1.7 Job Conditions:**

- A. Erection of steel shall be in proper sequence with the work of other trades. Steel shall be erected in a reasonable sequence and shall be guyed and braced as erected.
- B. Obtain complete field dimension prior to fabrication of steel. Re-check dimensions as steel is erected. Report deficiencies or errors to the Subcontract Administrator in writing in sufficient time to allow for corrections to be made prior to continuing work.
- C. Obtain setting bolt templates and setting drawings and install bolts at exact location in the structure.
- D. Subcontractor is responsible for maintaining surveying instrument and developing a procedure that permits complete quality control of steel erection. Columns shall be plum and horizontal members shall be level.

**PART 2 - PRODUCTS**

**2.1 Materials:**

- A. **Unfinished Bolts and Nuts:** Unfinished bolts and nuts shall conform to ASTM Standard A-307 and shall be the regular hexagon-bolt type.
- B. **Turned Bolts and Nuts:** Bolts and nuts shall conform to ASTM A - 307.
- C. **High Strength Bolts and Nuts:** Bolt and nuts shall conform to ASTM Specification A-325. Bolt and nut dimensions and threads shall be in accordance with American Standard B 18.22 for regular semi-finished hexagon bolts and heavy semi-finished hexagon nuts.
- D. **Washers:** Round washers shall conform to American Standard B27.2 Type B. Washers in contact with high-strength bolt heads and nuts shall be hardened in accordance with ASTM Standard A-325. Beveled washers shall be square, smooth, and sloped so that contact surfaces of bolt head and nut are parallel. The diameter of the hole of square-beveled washers shall be 1/16" greater than the bolt size for bolts not larger than 1", and 1/8" greater than the bolt size for bolts larger than 1".
- E. **Filler Metal for welding:** Welding electrode for manual shielded metal arc-welding shall conform to AWS Specifications. Bare electrodes and granular flux used in submerged-arc process shall conform to Section A.3.6 of AISC "Specifications for Structural Steel Buildings". Only E70 Series electrodes for manual arc welding and electrodes conforming to AWS A5.17-80 for submerged arc process shall be used for welding A-36 steel.
- F. **Shop Paint:** Rust inhibitive primer; TNEMEC 99 Series, or equal conforming to top coat as specified in Section 09900 PAINTING.
- G. **Cold Galvanized Compound:** High zinc content compound conforming to Military Specifications MIL-P-21035.

**PART 3 EXECUTION**

**3.1 Erection:**

- A. The framing shall be carried up true and plumb and temporary bracing shall be introduced wherever necessary to take care of the loads to which the structure may be subjected, including erection equipment and its operation. Such bracing shall be left in place as long as may be required for safety. It shall finally be removed by the Subcontractor as part of his equipment. As erection progresses, the work shall be securely connected to take care of all dead load, wind, and erection stresses.
- B. Set columns in exact position, in alignment, plumb and at proper elevations. Center of base plate shall be within 1/16 inch of true center line. Height shall be shimmed and grouted to 1/32 inch true height. Support base plate on leveling nuts until grouted and set.
- C. Erection bolts used as temporary anchorage for fully welded joints shall be removed after welds are complete and approved. In visible locations holes shall be plug welded solid. Bolted connections using machine bolts shall be peened to deface threads after bolts have been tightened.
- D. Furnish templates for setting anchor bolts or anchor plates that are to be cast into concrete. Furnish instructions for setting of anchors, connection details, length of exposed bolts, and other information necessary for the proper setting of embedded components.

**3.2 Bolted Field Connections:**



- A. Correction of mis-aligned holes at connections and base plates must be by methods approved by the Subcontract Administrator. Enlarged holes, when permitted, must be reamed to larger size. Do not burn holes to larger diameter. Mis-matched holes in any number makes the complete member subject to rejection without further comment.
- B. ASTM A-325 high strength bolts shall have suitable identification mark on heads. Tightening of nuts shall be in accordance with AISC "Structural Joints using ASTM A-325 or A-490 Bolts". Minimum bolt tension for the size of bolt uses shall be in accordance with tables listed in referenced standards. Tightening shall be accomplished using "calibrated wrench" method.
- C. When assembled, joint surfaces, including those adjacent to the washers, shall be free of scale except tight mill scale. They shall be free of dirt, loose scale, burrs, and other defects that would prevent solid seating of the parts. Contact surfaces with friction-type joints shall be free of oil, paint, lacquer or galvanizing.

**3.3 Welded Field Connections:**

- A. Each welder shall place his identification mark with paint (or stamp) near the welds he constructed, so that all weldments can be properly identified and associated with the correct welder.
- B. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale withstanding vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by mechanically guided torch.
- C. Clean tack welds and thoroughly fuse with final weld. Remove defective, cracked, or broken tack welds before final welding. Tack welds must be removed from joints where stress is primary, if welding is to be manual.
- D. Weld metal shall be completely sound and free of cracks in any weld or weld pass. Fill all craters to the full cross-section of the weld. Remove weld scale or slag, spatter, burrs, and other sharp or rough projections to leave the surface suitable for non-destructive testing, cleaning, and painting.
- E. Cut apart and reweld improperly fitted and misaligned parts. Remove cracked welds throughout their length.
- F. Straighten members distorted by heat of welding using mechanical means or by carefully supervised application of a limited amount of localized heat. Heated areas shall not exceed 1,200 degrees Fahrenheit as measured by Tempilsticks. Parts to be heated for straightening shall be free from external stress forces, except when mechanical means are used in conjunction with heat application.
- G. If faulty welding or its removal for rewelding damages the base metal so that, in the WRPE Designee's judgement, it is not in accordance with the intent of the drawings and specifications, remove and replace the damaged material and compensate for the deficiency in a manner acceptable to the WRPE Designee.
- H. Where work performed subsequently to the making of the deficient weld has rendered the weld inaccessible, or has caused new conditions which make connection of the deficiency dangerous or ineffectual, restore the original conditions by removing welds or members, or both before making the necessary corrections. Another option is to compensate for the deficiency with additional work according to the revised design, approved by the WRPE Designee.
- I. Beam flanges employing full penetration welds shall have 1-1/4" x 3/16" backup plate. Back gouge root pass and weld flush on backside of beam webs where full penetration is specified.



- J. Protect finish material from damage. Shield operations from wind currents. Do not perform welding operation during rainy weather or when temperature is below 40° degree F.
- K. Field weld joints which are to remain exposed shall be welded continuously regardless of strength requirements. Other joints may be skip welded as necessary to develop strength requirements. In all cases, connection shall be adequate to develop the full strength of largest member connected, regardless of actual requirements.

**3.5 Steel Joist:** Steel Joists shall be erected in accordance with Section 05210.

**3.6 Field Quality Control:**

- A. Corrective measures shall be taken when welding is unsatisfactory or indicates inferior workmanship. Chip and grind if the removal of part of the weld or a portion of the base metal is required. Where deposition of additional weld material is necessary, the sides of the area to be welded shall have no less than one to one slope to allow room for depositing new material. Correct defective or unsound welds by the removal and replacement of the entire weld using the following procedures:
  - 1. Excessive Convexity: Remove excess weld metal by grinding.
  - 2. Shrinkage Cracks, Cracks in Base Metal, Craters and Excessive Porosity: Remove defective portions of base and weld material down to sound metal, and deposit additional sound material.
  - 3. Undercutting, Undersize, and Excessive Concavity: Clean and deposit additional weld metal.
  - 4. Overlapping and Incomplete Fusion: Remove and replace the defective portion of the weld.
  - 5. Slag Inclusion: Remove those parts of the welds containing slag. Fill with sound weld metal.
  - 6. Removal of Adjacent Base Metal during Welding: Clean and form full size by depositing weld material.
- B. Field connections shall be visually inspected and physically tested as described above. Every connection must be identified by number and shall be approved by the WRPE Designee or Government's testing agency. Procedure for identifying faulty connections shall be determined by the WRPE Designee.

**3.7 Field Painting:**

- A. Shop painting shall be in accordance with the individual section of the specification. Finished painting shall be as specified in Section 09900 PAINTING. Apply one coat of paint to field welds, and bolts and as necessary to touch up damaged primer. Remove rust and apply same primer as specified.
- B. Galvanized metals shall be repaired with a cold applied zinc-rich paint. Coat welds, bolts damage to galvanized surfaces, and surface cuts made in the field.

**3.8 Clean and Adjust:**

After inspection and approval, the steel work shall be thoroughly cleaned of loose scale, rust, splatter, slag, flux, deposit, oil, dirt, and other foreign matter. Exposed steel shall be painted as specified in Section 09900 PAINTING.

**END OF SECTION**

**SECTION 05210**  
**STEEL JOISTS**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

Furnish labor, materials, equipment and incidentals necessary to install steel joists, bridging and accessories.

**1.2 RELATED WORK COVERED ELSEWHERE**

Structural Steel	Section 05120
Structural Steel Erections	Section 05121
Miscellaneous Metals	Section 05500

**1.3 SUBMITTALS**

Submittals shall be in accordance with general requirements and shall include shop drawings showing the size of steel joist, bearing details and extensions.

**1.4 REFERENCES AND STANDARDS**

Joist designations for Series K short span joists are the Steel Joist Institute's designation number, as listed in the "Standard Specifications and Load Tables." Joists shall conform to the following specifications and shall be capable of carrying the minimum loads listed in the load tables.

SJI Steel Joist Institute's Specifications and Load Tables, latest edition.

AISC Specifications for Structural Steel Buildings

AWS D1.1 Structural Welding Code-Steel

**1.5 DELIVERY HANDLING AND STORAGE**

A. Deliver joists at appropriate times to best expedite the construction and cause no delays. Make no deliveries until provisions have been made for storage prior to erection.

B. Store steel joists in upright position, held off of grade by wood supports, and anchored to prevent falling.

**1.6 JOB CONDITIONS**

Inspect joists upon delivery. Reject damaged joists. Any joist which has one or more chord members bent or crimped will be rejected by the Contracting Officer.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

A. STEEL: Hot rolled or cold formed steel, having a yield strength of 36,000 psi or 50,000 psi as used as a basis for the design stresses prescribed in Section 4 of SJI Specifications. The design of chord

sections for K-Series joist shall be based on a yield strength of 50,000 psi. K-Series joists shall be constructed of one of several steels recognized by the Steel Joists Institute, conforming to the requirements of AISC "Specifications for Structural Steel Buildings", and ASTM A-370.

- B. WELDING ELECTRODES: E70
- C. SHOP PAINT: Red oxide primer meeting Fed. Spec. TT-P-636.

## **2.2 FABRICATIONS**

- A. Joists shall be fabricated in accordance with the Standard Specifications of the Steel Joist Institute and shall conform to their design requirements.
- B. Joists shall have the minimum bearing areas as specified by the standard specifications. In no case shall the bearing lengths be less than 4-1/2" when bearing on masonry, or 2-1/2" when bearing on steel.
- C. Joists shall be constructed with extended bottom chords where required for suspended ceiling support, and extended top chords where required.
- D. Joist seats shall be of the depth noted on the drawings. Unless noted otherwise, series K joists shall have 2-1/2" deep seats.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Lift joists to the structure and distribute to avoid overloading any part of the structure. Space joists to proper dimension. Anchor joist seats and install bridging before any superimposed loads are applied.
- B. Fasten steel joists into place with fillet welds on each side of bearing plates at beams or weld plates. Provide standard masonry anchors for joists bearing into masonry. Tack weld steel joist to bearing members and install bridging. After bridging has been installed, complete anchorage by welding joist seats.
- C. Furnish and install continuous bridging to result in completely rigid members. Horizontal bridging shall consist of two (2) continuous horizontal steel members, one attached to the top chord and the other attached to the bottom chord. Bridging members shall have an l/r ratio not exceeding 300. Diagonal bracing shall consist of steel angles having a l/r ratio not exceeding 200. Angles shall be placed back to back and may be bolted or welded to steel plates attached to top and bottom chords of joist. In no case shall the number of rows of bridging be less than that specified in the SJI Specifications.
- D. Where concentrated loads are applied to either chord of steel joist, provide a 1-1/2" x 1-1/2" x 1/4" steel angle field welded between flanges of top and bottom chords, located at point where load is applied.
- E. Where columns are not framed in two directions with structural steel members, provide a steel joist centered on the column on either side, and bolted either to the flange of the longitudinal steel member or to seat brackets welded to the column. Anchor with two (2) 1/2" diameter bolts each joist.



**SECTION 05420**  
**GRATING AND STAIR TREADS**

**PART 1 - GENERAL**

**1.1**     **Scope:** Provide fabrication and erection of the grating and stair treads as shown on the drawings or required by other divisions of these specifications.

**1.2**     **References:** Industry publications controlling the work of this Division include:

**A.**       **American Society for Testing and Materials (ASTM):**

ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
ASTM A307	Carbon Steel Bolts and Studs, 60,000 psi Tensile.
ASTM A385	Providing High Quality Zinc Coatings
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A569	Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

**B.**       **American Welding Society (AWS):**

AWS D1.1	Structural Welding Code
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**C.**       **Federal Specification (FS)**

FS RR-G-661E	Grating, Metal, Bar Type (Floor, Except for Navy Vessels)
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**D.**       **National Association of Architectural Metal Manufacturers (NAAMM):**

Metal Bar Grating Manual
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**1.3**     **Submittals:** Submit the following to the Government in accordance with general requirements. Submittals are for approval

**A.**       Fabrication and erection drawings

**B.**       Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

**1.4**     **Quality Assurance:** Quality assurance for the work of this Section includes:

**A.**       Material or workmanship will be subject to Government inspection in the shop and field.

**B.**       Welders shall be qualified as prescribed in the AWS D1.1.

## PART 2 - PRODUCTS

- 2.1**     **Grating:** Grating shall be a galvanized, banded, type I, class 1, steel grating complying with FS RR-G-661E. Unless shown otherwise on the drawings, bearing bars shall be 1-1/2" x 3/16", spaced 1-3/16" on center, and cross bars shall be spaced 4" on center.
- 2.2**     **Stair Treads:** Stair treads shall be fabricated from grating and shall be as specified herein.
- A.       Bearing bars shall be not less than 3/16" x 1" spaced 1-3/16" on center.
  - B.       The nominal width of all stair treads shall be equal to or be the next nominal width greater than the tread run indicated on the design drawings.
  - C.       End carrier plates shall be provided. Bearing bars shall be attached to the carrier plates with fillet welds as detailed in the National Association of Architectural Metal Manufacturers' (NAAMM) "Metal Bar Grating Manual." Punching of carrier plates shall be as detailed in the same manual.
  - D.       Each tread shall be provided with a continuous steel abrasive nosing.
- 2.3**     **Bolts:** Bolts shall conform to ASTM A307 Grade A and nuts to ASTM A563. One common bolt assembly shall consist of a heavy hex head structural bolt, a heavy hex nut and a hardened washer.

## PART 3 - EXECUTION

- 3.1**     **Fabrication:** Fabricate all materials as specified herein.
- A.       All floor grating and stair treads shall be in accordance with the NAAMM "Metal Bar Grating Manual."
  - B.       Both ends of all sections of grating shall be banded.
  - C.       All gratings shall lie flat with no tendency to rock when installed. Poorly fitting grating will be rejected.
  - D.       All welding shall be done neatly and substantially, with all fillets dressed to uniform radius, all excess metal removed, and all welds ground smooth and flush. All welding shall comply with AWS D1.1.
- 3.2**     **Galvanizing:** All grating and stair treads shall be hot-dip galvanized after fabrication in accordance with ASTM A123, ASTM A153, and ASTM A385, unless noted otherwise. Materials specified to be galvanized shall be prepared for galvanizing by being properly cleaned, pickled, rinsed, and dried. The cleaned materials shall be immediately galvanized before any rusting can occur.

END OF SECTION

**SECTION 05500**  
**MISCELLANEOUS METALS**

**PART 1 GENERAL**

**1.1 Work Included:** Furnish labor, materials, equipment and incidentals necessary to fabricate and install miscellaneous metals and other ornamental or specialty work. Furnish hangers, supports, and brackets necessary to fasten other work.

**1.2 Related Work Covered Elsewhere:**

Structural Steel	Section 05120
Handrails and Guardrails	Section 05520
Painting	Section 09900

**1.3 Quality Control:** Field welding shall be performed by experienced operators, qualified in conformance with "Standard Qualifications Procedure" of the AWS "Structural Welding Code". Quality of welding shall conform to AWS Section 5-2.4.3 "Workmanship".

**1.4 Submittals:**

**A. Submittals shall be in accordance with general requirements and shall include:**

1. Shop drawings showing fabricated items.
2. Product data sheets for manufactured components.

**B.** Samples will be furnished when requested by the Subcontract Administrator. Samples shall be manufacturer's stock and shall be complete as required for installation into the structure. After approval the samples may be incorporated into the work.

**1.5 Standards and References:**

**A. Federal Specifications:**

FF-B-588	Bolt, Toggle, and Expansion Sleeve, Screw
FF-H-111	Hardware, Builders' Shelf and Miscellaneous
FF-S-85	Screws, Cap, Slotted and Hexagon-Head
FF-S-92	Screws, Machine: Slotted, Cross-Recessed or Hexagon Head
FF-S-111	Screw, Wood
FF-S-325	Shield, Expansion: Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
FF-W-84	Washers, Lock (Spring)
RR-G-661	Gratings, Metal, (Floor, Except for Naval Vessels)
RR-W-360	Wire Fabric, Industrial (Bird Screen)
RR-W-365	Wire Fabric, (Insect Screening)
TT-P-645	Primer, Paint, Zinc Chromate, Alkyd Type



TT-V-51                      Varnish; Asphalt

**B.     Military Specifications:**

MIL-P-6883                      Paint, Blended-Type, Coat-Tar-Pitch Base, Bituminous

MIL-P-21035                      High Zinc Dust Content, Galvanizing Repair

**C.     The Aluminum Association (AA) Publications:**

"Standards for Anodically Coated Aluminum Alloys for Architectural Applications."

"Designation System for Aluminum Finishes."

**D.     American Society for Testing and Materials (ASTM) Publications:**

ASTM A-36                      Specification for Structural Steel

ASTM A-53                      Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A-123                      Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A-153                      Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A-500                      Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A-525                      Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

**E.     American National Standards Institute (ANSI) Publication:**

ANSI A14.3                      Safety Code for Fixed Ladders

**F.     American Welding Society (AWS) Standard:**

AWS D1.1                      Structural Welding Code - Steel

AWS B1.10                      Guide for Non-Destructive Inspection of Welds

AWS A5.1                      Specification for Mild Steel Covered Arc Welding Electrodes

AWS A5.5                      Specification for Low Alloy Steel Covered Arc Welding Electrodes

**G.     Steel Structures Painting Council (SSPC) Publications:**

Steel Structures Painting Manual, Volume 2

**1.6     Delivery and Storage:**

Ship expansion joints to site in protective cartons.

**1.7     Job Conditions:**

- A.     Subcontractor shall verify all dimensions and shall take all field measurements necessary to establish size and connections prior to fabrication. Provide any anchors, brackets, supports, braces, connections and fasteners necessary to assemble the various components and anchor into position into the structure.

- B. Holes for bolts and screws shall be drilled or punched. Mismatched holes will not be allowed. Fasteners shall be concealed wherever possible. Exposed fasteners shall be of compatible materials and shall match color and finish of surrounding materials.
- C. Each component shall be of adequate size and strength necessary to fulfill its function. Failure of any part of the assembly is cause to reject the entire component. Component shall be assembled in a neat and substantial manner. Joints exposed to the weather shall be formed in a manner to exclude water.
- D. Items noted to be galvanized shall be hot dipped processed after fabrication. Galvanizing shall conform to the requirements of ASTM A-123, A-306, or A-525, as applicable. In addition to specific items shown or specified to be galvanized, galvanize items of this work which are fabricated of ferrous metal and exposed on or outside of the exterior surfaces of the building above or below grade. Galvanize after fabrication. Take proper precautions to prevent warping of the metal. Straighten any item that does become warped.
- E. Provide miscellaneous plates, brackets, frames, anchors and other steel fabrications as indicated on the drawings or required to make connections to components furnished under other sections of the specifications. Provide brackets for elevators and rails, precast concrete panels, and frames for mechanical equipment.

## **PART 2 - PRODUCTS**

### **2.1 Materials:**

- A. **Structural Steel:** ASTM A-36 having a minimum yield strength of not less than 36,000 psi.
- B. **Miscellaneous Steel:** Rolled shapes complying with ASTM A-36; plates and bars complying with ASTM A-284.
- C. **Structural Cast Steel:** Conforming to ASTM A-148, Grade 80-50.
- D. **General Purpose Cast Steel:** Conforming to ASTM A-27, Grade 65-35.
- E. **Steel Forging:** General purpose, conforming to ASTM A-668, Class C or F.
- F. **Cast Iron:** Soft, gray iron, conforming to ASTM A-48, Class 30, having 30,000 psi tensile strength.
- G. **Galvanizing:** Hot dipped, conforming to ASTM A-123, having a minimum coating of 2.0 ounces per square foot.
- H. **Welding Electrodes:** Appropriate for the intended usage. Electrodes for arc welding shall be series E70.
- I. **Aluminum:** Appropriate for the intended usage. Unless used adjacent to anodized aluminum surfaces, finish may be standard mill finish. Anodized coatings shall conform to The Aluminum Association "Standards For Anodically Coated Aluminum Alloys for Architectural Applications". Coating thickness shall be not less than specified in Aluminum Association "Designation Systems for Aluminum Finishes" for the particular application. Alloys shall comply with the following:

<u>Alloy</u>	<u>Usage</u>
6061	Extruded or rolled structural shapes
6063	Extrusions, general
3003	Sheet, tube or pipe

5005	General purpose sheet
5056	Nails and Rivets
2024	Screws, bolts and nuts

- J. **Stainless Steel:** Appropriate for the intended usage, complying with ANSI Type 300 or 301 (17%/7%) or 302 (18%/8%). Finish shall be No.4 Polished.
- K. **Steel Pipe:** Welded or seamless type, standard weight, schedule 40 steel tubing conforming to ASTM A-53. Steel tube shall conform to ASTM A 500, grade B.
- L. **Shop Paint:** Shop paint must be suitable for finish coats as specified in Section 09900 PAINTING. Subcontractor shall coordinate. Generally shop paint shall be a Zinc Chromate Primer for miscellaneous steel; TNEMEC 99 for structural components, and TNEMEC 10-99 for components to be fireproofed.
- M. **Fasteners:** Appropriate for the intended usage. Fasteners used with galvanized steel shall be zinc coated. Fasteners used on non-ferrous metal shall be bronze or brass. Fasteners shall include but not be limited to:
1. Steel bolts - Low carbon steel complying with ASTM A-307 or A-325.
  2. Nails and Spikes - Fasteners complying with Fed. Spec. IV. FF-P-636.
  3. Self Drilling Fasteners (SDF) - Corrosive resistant, hex-headed drill pointed, size as appropriate.
  4. Power Activated Fasteners (PAF) - Tempered A-151 steel with a minimum tensile strength of 270,000 psi, complying with Fed. Spec. - P3958, Ramset, Hilti, or equal.
  5. Sleeve bolts - Molly "Parasleeve", Ramset "Dynabolt", or equal.
  6. Concrete expansion bolts - Hilti "KwikBolt II", or equal.
  7. CMU Fastener - Hilti "KwikTog", or equal.
  8. Metal Deck fasteners - Corrosive resistant, hexheaded, drill pointed fasteners, Teks, or equal.
  9. Self-drilling anchors bolts - Zinc-plated, case hardened body with expanding plug, Ramset "RamDrill", Hilti "HHS" or equal.
- N. **Zinc-Rich Coating:** Specially formulated compound conforming to Navy Specification MIL-P-21035 that produces a coating of approximately 3.0 mils thickness containing not less than 95 percent zinc when applied in one coat according to manufacturer's instructions.
- O. **Bituminous Paint:** Heavy bodied asphalt based paint conforming to military specification MIL-P-6883 or Fed Spec TT-V-51.
- P. **Anchors and Bolts:** Anchors and bolts shall be stainless steel, cadmium plated or approved equal.
- Q. **Stud Anchors:** Stud anchors shall be as manufactured by Nelson Stud Anchors or equal.

## 2.2 **Fabrications:**

- A. Fabricated components shall be assembled in the shop whenever possible. Steel shapes shall be cut to accurate size with sharp lines and smooth surfaces. Thickness of metal and general construction shall be adequate to withstand the stresses imposed on the component. Provide lugs, brackets, or rivets necessary for connecting to other components.
- B. Connections shall be secure, either welded or fastened with bolts or rivets. Where the component is to be exposed to view, connections shall be by welding with the welds dressed smooth. Bolts or rivets may be used in unexposed locations.
- C. Structural fabrications shall be made of standard rolled shapes, plates, bars, or strips. Connectors shall generally be made by welding. All connections shall be rigid and secure.



**2.3 Manufactured Products:**

- A. **Steel Grating:** Steel grating shall be Pressure Locked rectangular design, as manufactured by IKG Industries or equal. Finish shall be one coat of black paint.

Grating shall be designed for a uniform distributed live load as shown on the plans.

- B. **Trolley Track and Carrier:** Furnish a 16 gauge galvanized steel trolley track having a 350 pound minimum capacity, such as Stanley No. X2641 or equal product as manufactured by Unistrut Corporation. Curved trolley track shall be a 16 gauge galvanized steel track having a 24 inch radius, 90 degree turn, such as Stanley No. X2641CT or equal. Carrier shall be a bright zinc plated assembly with ball bearing wheels, having a minimum capacity of 175 pounds, such as Stanley No. BBXT2600 or equal.

- C. **Safety Treads:** Safety treads and nosings shall be 3" wide abrasive-surfaced nosings cut to full width of stairs minus 1/8" each side for stairs, and width of concrete steps minus 3" each side for exterior concrete steps. Safety treads shall have integral anchors for embedding into concrete. Treads shall be as manufactured by Wooster, American Abrasive Metal Company, Mason Safety Tread Company, Armstrong products, or approved equal.

- D. **Channel Framing System:** Steel "C" galvanized channels of required type designed to accept a special spring loaded nut for cable tray support. Touch-up damage due to installation with zinc-rich coating. Unistrut Corporation - P1001, P3300 (concrete inserts). Or equal.

- E. **Insect Screen:** Federal Specification RR-W-365, Type II, III, or VII, 18 by 16 mesh, or Federal Specification L-S-125, Type II, 18 by 16 mesh. Color to match louver.

- F. **Bird Screen:** Aluminum wire screen conforming to Fed Spec RR-W-360, Type I, Class 1, and shall be 1/2 by 1/2 mesh, 0.063 inch diameter aluminum wire. Color shall match louver.

- G. **Steel Plate:** Furnish steel plate for fabrication as indicated on the drawings. Furnish 1/4" or 3/8" thick checkered steel plate where indicated.

- H. **Access Ladders:** Manufacturer's standard design aluminum access ladder conforming to OSHA requirements and fabricated of aluminum side rails with non-slip safety rungs. Wall anchors shall be stainless steel, cadmium plated or other non-corrosive metal, as approved by the WRPE Designee. Provide ladders at locations shown on drawings.

- I. **Aluminum Sills:** Extruded of 6063-T52 alloy, J.C. Braum & Company, model AA, complete with SA-100 anchor clips, or approved equal. Finish shall be anodized to match window.

- J. **Window Stools:** Interior window stools shall be fabricated of 0.70 gauge aluminum, with clear anodized finish.

- K. **Antenna Mount:** Provide special fabrication at cab roof for antenna mounts as detailed on the drawings. Provide 2-1/2" 1.0 threaded schedule 42 pipe nipples inserted into threaded nuts. Install steel air terminal brackets and air terminals as indicated.

- L. **Miscellaneous Steel Fabrications:** Fabricate miscellaneous fabricated steel components such as window shade pockets, coordinator jacks, hoist access openings, frame supports, ceiling panel supports and other hangers or brackets indicated on the drawings or as required to complete the installation.

- M. **Floor Hatch Guardrails:** Construct special guardrails to the details indicated on the drawings at floor hatches. Guardrails shall be all welded construction, designed to be pivoted and pinned, capable of being lowered into the hatch opening when not in use.
- N. **Access Skirt:** Construct a sheet metal skirt at ceiling access ladders to form a separation from the opening and the above ceiling space. Skirt to be all welded construction and shall extend from the access ladder frame to the floor opening above.

**2.4 Steel Frames:**

- A. Frames shall not have less than two (2) structural members which span across adjacent purlins. Openings shall be framed with steel angles of a size suitable for the opening size. When wood curbs are detailed as part of the frame design, provide angles having outstanding legs turned upward, with holes punched for attaching wood curbs. Holes shall be spaced at 12" inch centers, with no side having less than three fasteners. Size of frames and opening dimensions shall be coordinated with equipment manufacturer. Minimum size of supporting angles shall be 3½" x 5" x 1/4".
- B. Frames used to support roof top air conditioning equipment shall have additional members to frame each duct penetration of the roof surface. As well as a structural member corresponding to the mounting curb perimeter dimensions of the mechanical equipment.
- C. Frames for roof drains and any other roof penetration not exceeding 24 inches square shall be a minimum size of 2½" x 2½" x 5/16". All other frames shall be as detailed on drawings, otherwise shall be framed with steel angles having a minimum size of 4" x 4" x 5/16".

**2.5 Cast Iron Castings:** Casting shall be uniform in quality, free from blow holes or other defects. Surface shall be smooth and true to pattern. Metal shall conform to ASTM A-48, Class 40 for grey cast iron castings. Castings shall receive one coat of rust inhibited primer and shall be field painted as specified in Section 09900, PAINTING. Casting shall include the following:

- A. Manhole Covers and Frames
- B. Trench Drains

**2.6 Bronze Castings:** Castings shall be uniform in quality, free from injurious defects with smooth surfaces and true to pattern. Casting metal shall be CDA Alloy 844. Casting shall include the following:

Downspout nozzle: Josam 25010 Series or approved equal, satin-finish bronze nozzle with loose all flange and inlet threaded connection, size as required.

**2.7 Architectural Expansion Joint Covers:** Components shall be as manufactured by Architectural Arts Mfg. Inc., Balco, Inc., Construction Specialties, Metalines, Inc. or approved equal. Expansion joints shall be fabricated of extruded aluminum 6063-T5 and shall be of the shape and type necessary for the particular application, equal to the following:

Floors	Balco type 4FP-1 or 4FVP-1
Walls	Balco type 6ADW-1 or 6ADWC-1
Gypsum wallboard	Balco type FWG-1 or CFWG-1
Floors	Balco type 4FL-1 or FVL-1
Heavy duty covers	Balco type XH4FS-1m or XH4VS-1m

**2.8 Fabricated Stairs:**

- A. Stairs shall be fabricated to the sizes and slopes indicated on the drawings. Stair stringer shall be fabricated of structural steel shapes cut to proper design and fitted with lugs, brackets and connection



angles as necessary to erect and assemble the various components. Stairs shall be capable of sustaining their own weight plus a live load of 100 pounds per square foot, or a moving concentrated load of 1000 pounds. Design and strength shall conform to the requirements of "Metal Stairs Handbook of the National Association of Architectural Metal Manufacturers".

- B. Stairs shall be partially assembled at factory, complete with connection angles and other fasteners and ready for final assembly at job site.
  - C. All parts of stair fabrication exposed to view when assembled shall be constructed with all welded fabrication with welds continuous and ground smooth, resulting in an invisible joint. Field connections exposed to view shall be welded. Concealed joints may be bolted or welded type.
- 2.9 **Fabricated Gates:** Subcontractor shall fabricate steel gates as indicated on the drawings. Gates shall be shop fabricated of the sizes and in accordance with details on drawings. Provide three (3) heavy fabricated hinges at each gate leaf and weld to supporting post. Provide gate keepers at each gate leaf as well as shape for a padlock.

### **PART 3 EXECUTION**

#### **3.1 Preparation:**

- A. Inspect surfaces to receive metal components. Ascertain that surfaces are suitable for the attachment of the component.
- B. Drill, punch, cut and tap steel as required for anchoring or accommodating the work of other trades as shown or where instructions for same are given prior to or with approval of Shop Drawings.
- C. Visible joints shall be close fitting, neat and tight. Assemble joints so that they will be as strong and rigid as adjoining section. Make up threaded connections tightly so that threads will be entirely concealed by fittings. Except as otherwise shown, specified or approved, weld shop assembled connections. Rivets, bolts, or machine screws may be used for field connections. Visible rivets bolts, screws, etc., shall have flush or oval heads and shall be countersunk. Seal-weld visible joints and exposed joints their entire length. Other joints may be spot or skip welded unless shown otherwise, or unless they must be continuous. Grind welds where required.

#### **3.2 Installation:**

- A. **Grating:** Provide grating and frame to support it, in required size. Provide a band where edge of grating is open and visible, and at perimeter of cutouts. Fasten grating to frame at the ends of the third bearing bar from each side of the panel and to intermediate supports at the middle of the panel. Weld frame to imbedded plates as shown on the drawings. Where hinged grating is indicated, provide a steel angle frame around opening. Provide extra heavy duty hinges and weld to grating and frame. Provide toe guards at openings in gratings where conduit or piping extends through grating flooring. Toe guards may be 1/4" x 4" steel plates or 3" x 4" x 1/4" steel angles bolted or welded to grating.
- B. **Access Ladders:** Install access ladders at locations specified. Provide steel clip angles at each leg and attach to concrete floor with expansion bolts. Provide steel strap supports to ladder legs and attach to construction with expansion bolts or by welding, as appropriate.
- C. **Safety Treads:** Install safety treads at each concrete step on the interior and exterior of the building. Safety tread shall be cast into concrete so that top of tread is flush with concrete surface.
- D. **Hatchway:** Frames shall be cast in place with the concrete structure. Provide copper or PVC tubing drain and attach to drain nipple and extend to the outside. Hatchway shall be set plumb and level.



- E. **Joist Anchors:** Furnish a steel anchor plate for each joist seat fabricated of steel plate with stud anchors. Unless noted otherwise, anchors for "K" series joists shall be 4" x 6" x 1/4" inch plates with two (2) 1/2" x 5" inch long stud anchors, and anchors for long span joists shall be 5" x 9" x 1/4". Anchor plates shall be cast into concrete masonry tie beam at joist locations.
- F. **Anchor Plates:** Furnish steel anchor plates to be cast into concrete structure and to be used for attaching precast concrete panels or steel members. Anchor plates shall be unpainted steel, except for where plates are installed in exterior surfaces or within one inch of the exterior surface which shall be hot dip galvanized after fabrication.
- G. **Window Sill:** Furnish and install a window sill at every window opening and louver location. Sills shall be the size required by the condition. Anchor clip anchor to masonry and snap sill into place. Set sill in full bed of mastic.
- H. **Hangars and Straps:** Provide metal hangars, straps, and bracing required to support and secure other work unless specifically shown or specified to be provided by another trade. Carefully coordinate this work.
- I. **Microwave Frame:** Provide special microwave frames and brackets for mounting microwaves to design indicated on drawings.
- J. **Miscellaneous Steel Fabrications:** Fabricate miscellaneous fabricated steel components such as window shade pockets, gun housings, coordinator jacks, hoist access openings, frame supports, ceiling panel supports and other hangers or brackets indicated on the drawings or as required to complete the installation.
- K. **Steel Grating Floors:** Provide steel grating at flooring of electrical chases and as indicated on the drawings. Provide supplementary steel framing at edges of grating at electrical trays and around access openings. Provide a hinged section of grate at each ladder. Hinges shall be heavy duty galvanized steel, 5 pin strap hinges welded to grating frame. Provide a 1 1/4" x 1 1/4" x 1/4" angle frame around hinged section and edge of opening around perimeter. Miter corner and weld a frame, then weld to grating. Hinges to be welded to angles.
- L. **Floor Hatch Guardrails:** Construct special guardrails to the details indicated on the drawings at floor hatches. Guardrails shall be all welded construction, designed to be pivoted and pinned, capable of being lowered into the hatch opening when not in use.
- M. **Access Skirt:** Construct a sheet metal skirt at ceiling access ladders to form a separation from the opening and the above ceiling space. Skirt to be all welded construction and shall extend from the access ladder frame to the floor opening above.
- N. **Antenna Mount:** Provide special fabrication at cab roof for antenna mounts as defined on the drawings. Provide 2 1/2 1.0 threaded schedule 42 pipe nipples inserted into threaded nuts. Install steel air terminal brackets and air terminal as indicated.

### 3.3 **Steel Stairs Erection:**

- A. **Furnish steel stair framing:** Stairs shall be partially assembled in the shop by welding and shall be erected in place at the job site. Furnish connection plates, splices, brackets and other components necessary to make the connections in the field. Erect components in place, true and level. Miter splices and fit carefully. Structural members not normally exposed to view may be assembled by bolting. Field weld all other connections with welds which are continuous and ground smooth. Joints in stringers shall be welded continuous where exposed to view and welds ground smooth.

- B. Stair pans shall be formed of 14 gauge steel, shaped to conform to stair details. Stair pans shall be field tack welded to steel angles welded to stair stringers at each side bearing. Provide steel plate landings and miscellaneous angles and braces as indicated on the drawings or necessary to complete the project. Provide not less than three (3) 3 inch channel supports at landings, unless shown otherwise on drawing.
- C. Provide concrete fill at each stair tread, complete with safety tread at nosing. Safety tread shall be 1" less than stair width on each side of stairs. Provide temporary wood plank fillers for treads and landings until concrete fill has been placed.
- D. Stairs shall be of equal width having risers of equal height. In any run of stair the height of riser shall not vary by more than 1/8" between any two risers.
- E. Stairs shall properly fit abutting building components. Perform cutting, fitting, drilling and fastening required to complete the work. Erect stairs plumb, level and free of deflection or vibration. Provide brackets and connection plates as necessary to connect to structure. Provide fill plates where necessary to close gaps between stringers and wall surfaces.
- F. Handrails for stairs shall be 1-1/4" diameter steel pipe with welded construction. Posts may be welded to top of stairs stringer or may be welded to a connection plate which in turn is welded to the stringer. Return ends of railings to walls. Splices in handrails shall be completely welded and filled, then ground smooth.

#### 3.4 **Fasteners:**

- A. Furnish the appropriate type of fastener for the application. Fasteners shall be of the type and material proper for intended use and in sufficient quantity for the spacing. Bolts shall be a minimum of 1/2 inch diameter, spaced not to exceed three foot center for attaching steel, or two feet centers for attaching wood.
- B. **Generally use the following fasteners as designated:**
  - 1. Masonry: Machine bolts with lead or malleable iron expansion shields, or toggle bolts as appropriate.
  - 2. CMU: Toggle bolts.
  - 3. Concrete: Embedded bolts, cast-in-place inserts with twist in bolts, or expansion bolts with expansion shields.
  - 4. Gypboard: expansion anchors or toggle bolts.
  - 5. Wood to metal: machine bolts with washers and nuts.
  - 6. Wood: wood screws, lag screws, proper nails as appropriate.
  - 7. Wood to concrete: cast in place anchor bolts, expansion bolts or power driven fasteners.

#### 3.5 **Architectural Expansion Joint Covers:**

- A. Furnish and install expansion joints at any exposed location that expansion joints occur, generally flush to surfaces. Expansion joints shall be the manufacturer's standard design similar to those specified. Provide fasteners of the appropriate type for the installation and attach securely. Install expansion joints at floors, walls, and ceilings.
- B. Protect aluminum surfaces in contact with concrete with a coat of zinc chromate or bituminous paint.
- C. Once expansion joints have been installed, protect from damage by covering them with walkboards or other appropriate methods.

**3.6     Field Quality Control:**

- A.     Clean all surfaces, remove rust and prepare for painting. Surfaces which will be in accessible after fabrication or erection shall be painted prior to installation.
- B.     Except for galvanized steel and items specifically noted not to be painted, all miscellaneous metal components shall receive a shop coat of paint. Paint shall be applied by brush or spray, applied uniformly without runs or ships. Field painting shall be in accordance with Section 09900 Painting.
- C.     Any fasteners or miscellaneous components applied on galvanized fabrications shall be galvanized, chromeplated, otherwise shall be painted with zinc-rich coatings.
- D.     Dissimilar materials: Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, pressure-treated wood or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint, unless otherwise specified, to prevent galvanic or corrosive action.

**END OF SECTION**



## **PART 1 - GENERAL**

- ## 1.2 Related Work Covered Elsewhere:

Cast in Place Concrete	Section 03301
Miscellaneous Metals	Section 05500
Painting	Section 09900

- ### 1.3 Quality Control:

- A. **Suggested Manufacturers:** Aluminum handrails by the following Manufacturers that comply with these specifications will be acceptable:
1. Julius Blum & Co., Inc.
  2. Architectural Art Manufacturing Company, Inc.
  3. Rocky Mountain Railing
  4. Thompson Fabrication Company
  5. Reynolds Aluminum
- B. **Design Criteria:** Guardrails and handrails shall be designed to resist a concentrated load of 200 pounds applied to the top rail at any point and in any direction. Deflections resulting from such stresses shall not be permanent.
- C. **Style:** Handrails and guardrails shall be multi-rail type. The number of rails shall be as indicated on the plans, or as required by local codes or OSHA requirements. Railings accessible to the public shall be designed so that the clear spacing between horizontal rails or the distance between vertical members on picket-type railings shall not exceed 6", except 4" at exit stairs. Returns and rail extensions beyond end of stairs shall comply with OSHA and Fed Std 795 "Uniform Federal Accessibility Standards".
- D. **Tolerances:** The railing system shall be installed to the following tolerances:
1. Maximum variation from plumb 1/4"
  2. Maximum offset from alignment 1/4"

- 1.4 Submittals:** Submittals shall be in accordance with general requirements and shall include:

- A. Certification of compliance with local, state, and Federal codes, and OSHA requirements.
- B. Shop drawings indicating railing layout, methods of assembly, attachments, anchorage types, and expansion joints.

- 1.5 Standards and References:** The applicable provisions of the following standards shall apply as if written here in their entirety:

ASTM A-36	Specification for Structural Steel
ASTM A-53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM B-221	Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM E-894	Standard Test Methods for Anchorage of Permanent Metal Railings and Rails for Buildings
ASTM E-985	Specifications for Permanent Metal Rails for Buildings
ANSI A 21.1	Safety Requirements for Floor and Wall Openings, Railings, and Toe Boards
AWS	Structural Welding-Code
OSHA 29 CFR 1910	Occupational Safety and Health Standards
UBC, 1991	Uniform Building Code

**1.6 Job Conditions:**

- A. The SubSubcontractor shall be responsible for taking complete field measurements of all areas scheduled for guardrails or handrails to assure a proper fit to field conditions.
- B. Provide any concrete inserts required by the railing anchorage.
- C. Provide handrails at both sides of stairs. Where sides of stair consists of a solid wall, a single handrail may be provided along with handrail brackets to anchor handrail to wall surface. Provide backup blocking at drywall partitions.

**PART 2.00 PRODUCTS**

**2.1 Materials:**

- A. **Steel Pipe:** I.P.S. Schedule 40 steel pipe conforming to ASTM A-53. Sizes are shown on drawings for different locations.
- B. **Toe Boards:** Extruded aluminum alloy 6063-T52, conforming to ASTM B-221 and ASNI A12.1.
- C. **MECHANICAL FASTENERS:** Furnish mechanical fasteners as recommended by the manufacturer for the following conditions:
  - 1. Stainless steel RHMS 1/4", 20" x 1" SEMS with lock washers.
  - 2. Stainless steel 1/4", 20 RHMS with nut.
  - 3. Aluminum, internally threaded, tubular rivets
  - 4. Cadmium-plated sleeve anchor bolts, 3/8" x 3".
- D. **Structural Adhesive:** An approved epoxy adhesive, as recommended by the railing manufacturer, such as 3M "SCOTCH-WELD", or approved equal.
- E. **Post Setting Epoxy:** Silicone Specialties "E-Bond #165", Sika Corp. "Sikador Hi-mod", or approved equal.
- F. **Steel Anchor:** Anchor and other appurtenances shall conform to ASTM A-36.
- G. **Welding Electrodes:** Conformed to AWS Code.

**2.2**     **Finish:** Finish for interior exposed steel handrails shall be painted as per color schedule. Steel handrails, exposed to the exterior shall be fabricated of galvanized steel.

**2.3**     **Welded Steel Railings:**

- A.     Steel handrails and guardrails shall be fabricated of I.P.S. Schedule 40 steel pipe with all welded construction. Cut pipe intersections to the diameter of the connecting pipe and weld all around the connections. Posts shall be truly vertical and shall be welded to steel stair stringers all around the pipe diameter shop welded to a steel base plate, as indicated. The steel pipe diameter is 1 1/4" or 4" as shown on the drawings.
- B.     Furnish fabricated welding type fittings, including end terminals which curve and anchor to the wall, pipe end terminals, bases, wall brackets, and wall flanges. Railings shall have rounded corners and returns using flush welded fittings.

**PART 3 - EXECUTION**

**3.1**     **Preparation:** Install sleeves and anchor plates in concrete as it is placed.

**3.2**     **Installation:**

- A.     Post spacing shall not exceed maximum spacing required by local or state codes, or OSHA requirements, or 8'-0" centers; whichever is less. Handrail posts at stairs shall be spaced as required to produce uniform spacing between posts.
- B.     Provide extensions at both ends of the stair terminals, in accordance with OSHA requirements. Extend wall mounted handrails a minimum of 12" beyond the end of the stair. Handrails at stairs shall have a height as shown on drawings. Guardrail heights shall be 3'-6". Make smooth radius transitions between the stair rails and guardrails. Transitions from horizontal rails to sloping rails and terminations at ends of railing shall have rounded corners.
- C.     Install toe boards between posts at locations indicated on the plans or required by OSHA. Toe boards shall be shipped in 4' lengths and cut to fit in the field. Attachment shall allow the metal to expand and contract. Splices shall occur only at vertical posts.
- D.     Provide splices and expansion joints, each having an internal splice connector. Install expansion joints according to the Manufacturer's recommendations. Expansion joints shall be free to move on one side and shall not exceed intervals of 25' on straight runs.
- E.     Apply one (1) coat of zinc chromate or bituminous paint with a minimum thickness of 10 mils dry film thickness at railing components in contact with concrete or dissimilar materials.
- F.     Welded systems shall have all joints welded continuously around each juncture with small, uniform welds. Steel welded pipe shall have welds ground smooth. Aluminum welds, if neatly made and uniform in appearance, need not be ground, except when appearance is a factor and welds are not made neatly and smoothly as determined by the Subcontract Administrator.
- G.     Provide a 3/16" stainless steel safety chain attached to an eye-bolt at the vertical post, where indicated on the plans. Provide a spring loaded clip at the opposite end.



- H.** Provide 3/16" diameter weep holes located 1/4" to 3/4" above the grout line at exterior posts set in grout or concrete.
- I.** **Painting:** Steel handrails shall be painted as specified in Section 09901, Painting, Galvanized steel handrails do not require painting.

**END OF SECTION**

**SECTION 07700**  
**ACCESS HATCHES**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

Furnish labor, materials, equipment and incidentals necessary to install a double door access hatch indicated in drawings and specified herein.

**1.2 RELATED WORK COVERED ELSEWHERE**

Structural Steel	Section 05120
Structural Steel Erections	Section 05121
Miscellaneous Metals	Section 05500
Painting	Section 09901

**1.3 SUBMITTALS**

Submittals shall be in accordance with general requirements and shall include:

- A. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected Work.
  - i. Hatch Units: Show types, elevations, thickness of metals, and full size profiles.
  - ii. Hardware: Show materials, finishes, locations of fasteners, types of fasteners, locations and types of operating hardware, and details of installation.
  - iii. General: Show connections of units and hardware to other Work. Include schedules showing location of each type and size of unit.
- B. Product Data: Manufacturer's technical data for each type of hatch assembly, including setting drawings, templates, finish requirements, and details of anchorage devices.
  - iv. Include complete schedule, types, locations, construction details, finishes, latching or locking provisions, and other pertinent data.
- C. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.
- D. Quality Control Submittals:
  - v. Statement of qualifications.
- E. Contract Closeout Submittals.
  - vi. Operating and maintenance manuals.

**1.4 QUALITY ASSURANCE**

- A. Qualifications:

Manufacturer/Installer: Company specializing in manufacturing and installation of components specified in this Section with minimum of 5 years documented experience.

**1.5 DELIVERY HANDLING AND STORAGE**

- A. Deliver materials to Project site ready use.
- B. Exercise proper care in handling of Work so as not to injure finished surfaces. Protect Work from damage after it is in place.

- C. Store materials under cover in a dry and clean location off the ground. Remove materials that are damaged or otherwise not suitable for installation from Project site and replace with acceptable materials at no additional cost to Owner.

#### 1.6 **WARRANTY**

- A. Provide manufacturer's written 5-year warranty.
- B. Warrant materials and workmanship against defects after completion and final acceptance of Work.

### **PART 2 – PRODUCTS**

- 2.1 **SUGGESTED MANUFACTURERS:** Access hatches by the following Manufacturers that comply with these specifications will be acceptable.

- 1. The Bilco Company
- 2. Babcock Davis, Inc.
- 3. Acudor Products, Inc.
- 4. JL Industries, Inc.

#### **ACCESS HATCH**

#### 2.2

- A. Furnish and install where indicated on plans a metal access hatch for a clear opening size of 3'-6" (width) x 7'-6" (length). Length denotes hinge side. The access hatch shall be double leaf. The access hatch shall be preassembled from the manufacturer.
- B. Performance characteristics
  - i. Covers shall be reinforced to support a minimum live load of 60 psf with a maximum deflection of 1/150th of the span or 20 psf wind uplift
  - ii. Operation of the covers shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
  - iii. Operation of the covers shall not be affected by temperature
  - iv. Fully welded corner joints on covers and curb.
- C. Lifting mechanisms: Manufacturer shall furnish hinge mechanisms that provide smooth, easy, and controlled cover operation throughout the entire arc of opening and closing.
- D. Hardware
  - i. Heavy pintle hinges shall be provided
  - ii. Covers shall be equipped with an enclosed two point spring latch with interior and exterior turn handles.
  - iii. Access hatch shall be equipped with interior padlock hasps on the underside of panels such that a padlock can be used to lock the opening closed.
  - iv. The latch strike shall be a stamped component bolted to the curb assembly.
  - v. Covers shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25.4mm) diameter red vinyl grip handle to permit easy release for closing.
  - vi. Each leaf (interior/underside) should have an ADA compliant (strength/dimensions) aluminum handrail attached to it and a sliding bar lock such that the leaf can be locked in the vertical position so that the handrail can be used for moving up and down the stairs.
  - vii. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed.



- E. Finishes: Factory finish shall be alkyd based red oxide primed steel

### **2.3 FINISHES**

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Steel: Manufacturer's standard factory-applied powder coat finish, red oxide standard color.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Verify that top level deck steel elements, expanded metal grating, and other items affecting Work of this Section are in place and positioned correctly.
- C. Verify tolerances and correct improper conditions.
- D. Do not proceed until unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Submit product design drawings for review and approval to the owner before fabrication.
- B. Install roof accessory items and components per manufacturer's instructions.
- C. Coordinate installation of components of this Section with installation of top level deck and top level steel elements.
- D. Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.
- E. The installer shall furnish mechanical fasteners consistent with the access hatch requirements.

### **3.3 ADJUSTING**

- A. Adjust movable parts for smooth operation.
- B. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

### **3.4 CLEANING**

- A. Clean exposed surfaces per manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION

**SECTION 09260**  
**GYPSUM DRYWALL**

**PART 1 – GENERAL**

**1.1 General:** The Subcontractor shall furnish and install gypsum board for walls and partitions as indicated on the drawings complete with metal wall framing, conforming in construction method described in indicated fire resistance test to provide a fire rated assembly. Except where otherwise indicated or specified hereinafter, the work shall conform to ASTM C 645, ASTM C 754, and ASTM C 840.

**1.2 Applicable Documents:** The following publications of the issues in effect on the date of Request-for-Proposal form a part of this section of specifications to the extent referenced.

**1.2.1 American Society for Testing and Materials (ASTM):**

- C 36 Gypsum Wallboard
- C 645 Nonload (Axial) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screw Application of Gypsum Board.
- C 754 Installation of Steel Framing Members to Receive Screw-Attached Gypsum Wallboard Backing Board, or Water Resistant Backing Board.
- C 840 Application and Finishing of Gypsum Board

**1.2.2 Underwriters Laboratories (U.L.):**

Building Materials Directory (1993)  
Fire Resistance Directory (1993)

**PART 2 - PRODUCTS**

**2.1 Gypsum Board:** Gypsum board shall conform to ASTM C36, Type C or X, as indicated on the drawings, and taper-edged, unless otherwise indicated. Bestwall, Celotex, Flintkote, Kaiser, National Gypsum, U.S. Gypsum or approved equal, carrying Underwriter's Laboratories label, 4 feet wide and up to 14 feet long as applicable to project conditions, may be used.

**2.2 Framing Members:** Non-load (Axial) bearing steel studs, runners (track), and rigid furring channels for screw application of gypsum board shall conform to the requirements of ASTM C 645 and shall be hot-dip galvanized. Studs, runners (track), furring channels, and grid suspension systems shall be designed for flush batten installation of board, fabricated by one manufacturer, and shall conform to the following requirements.

**2.2.1 Ceiling and Floor Runner Channel:** Shall be not less than 0.021-inch nominal thickness with 1-1/4-inch flanges and channel web sized to nest with comparable steel studs.

**2.2.2 Furring Channels:** Shall be not less than 0.021 inch nominal thickness, hat-shaped in section with 1-3/8-inch wide crown for wallboard attachment. Hat crown shall be 7/8-inch deep and brim shall be formed with 1/2-inch flanges stiffened with 1/8-inch folded edge. Flanges may be 3/8-inch when 1/8-inch stiffened edge is upturned 90 degrees from the brim. Crown shall be slightly sloped for nesting channels.



**2.2.3 Non-Load Bearing Studs:** Studs shall be C-shaped, not less than 0.021-inch nominal thickness with web dimension of 6 inches as indicated. Stud flanges shall be not less than 1-5/16 inches and each flange shall have a stiffening lip bent parallel to the stud web.

**2.2.4 Lateral Braces:** 3/4-inch wide 25 gauge cold rolled hot-dip galvanized steel channels.

**2.3 Fastenings:** Metal screws conforming to ASTM C1002 or C954 shall be not less than 1 inch long with self-tapping threads and self-drilling points, type S, for base layer. Screws 1-5/8-inches long shall be used for second ply attachment in two ply application. Hanger wire: 9-GA., Galvanized. Tie wires: 18-GA., Galvanized. Fasteners used in fire rated assemblies shall conform to the requirements of the applicable tested assembly.

**2.3.1 Retainer Strips:** 1-1/4" drywall sheet metal screws.

**2.3.2 Runner Tracks:** Expansion anchors into concrete, screws or bolts into metal and wood at 24 in. on center.

**2.4 Gypsum Board Joints:** Tape, float and sand smooth as recommended by gypsum board manufacturer. Taping and embedding compound meeting ASTM C475; and finishing and topping compound shall be asbestos-free, pre-mixed and specifically formulated and manufactured for use in gypsum board joints.

### **PART 3 – EXECUTION**

**3.1 Construction:** When the gypsum board is to be applied to both ceiling and walls, apply the gypsum board first to the ceiling and then to the walls.

**3.1.1 Steel Framing:** Steel framing members shall be installed in accordance with ASTM C 754. Non-load bearing walls and partitions shall be framed with 6 inch steel studs and runners as indicated on the drawings. Ceiling framing shall consist of 1-1/2 inch steel, cold rolled, carrying channels suspended plumb from structural members, by hanger wires or straps, spaced at not more than 4 feet on centers and within 6" of walls, unless otherwise specified on the drawings. Erect metal furring channels at right angles to carrying channels. Conform to manufacturer's published charts for partition unbraced heights; provide diagonal bracing at concealed locations where allowable unbraced heights are exceeded.

**3.1.2 Studs:** Space studs of required width at 16 inches o.c. unless shown or noted otherwise. Locate a boxed stud, formed by interlocking a stud and runner channel, with web against and securely fastened to jambs of door frames at openings, and to abutting walls of dissimilar materials. Construction of framing above openings shall be as approved on the shop drawings. Secure studs to runner with screws at opening frames and corners. Provide blocking, headers, and supports for any wall hung accessory.

**3.1.3 Lateral Braces:** Brace studs in accordance with drywall system manufacturer's recommendations with 3/4-inch channel at the 1/3 elevation points of the partition and attach with 1/2-inch type S-12 drywall screw.

**3.1.4 Application of Gypsum Board:** Gypsum boards shall be applied in accordance with ASTM C 840 and/or the applicable fire rated assembly as described in the UL Fire Resistance Directory, except as otherwise specified herein.

**3.1.4.1 Base Layer:** Use regular face board except where other types are required. Apply vertically without horizontal joints at walls up to 14 feet high. Center all vertical joints over stud flange. Fasten board to studs with 1 inch type S wallboard screws at maximum 12 inches on centers. Offset vertical joints 16" on the opposite sides of the partition. Extend board full depth into opening frames.



**3.1.4.2 Face Board:** Face board shall be laminated to base layer using adhesive recommended by gypsum board manufacturer and fastened with 1-5/8" type S wallboard screws at 16 inches on centers. Dimple screw heads below surface at board. Joints shall be staggered 16" from the base layer.

**3.1.5 Attachment:** Screws shall be driven with clutch-controlled power screw drivers or approved equal. Screw spacing shall be as specified hereinbefore.

**3.1.6 Joint and Fastener Concealment:**

**3.1.6.1 Areas to be treated:** Shall be inspected by the RE to ascertain that wallboard fits tightly against supporting framework, and these areas shall be heated to not less than 55 degrees F, for 24 hours prior to commencing treatment. Application shall be by machine or hand tool. A minimum drying time of 24 hours shall be allowed between adhesive coats.

**3.1.6.2 Embedding compound:** Shall be applied to wallboard joints and fastener heads in a thin uniform layer. Compound shall be spread not less than 3 inches wide at joints, and reinforcing tape shall be centered on the joint and embedded in the compound. A thin layer of compound shall then be spread over the tape. After this treatment has dried, a second coat of embedding compound shall be applied to wallboard joints and fastener heads. Compound shall be spread in a thin uniform coat and to not less than 6 inches wide at joints. Treated areas shall be sanded to eliminate ridges and high points.

**3.1.6.3 Finishing Compound:** After embedding compound has dried, a coat of finishing compound shall be applied to joints and fastener heads. Finishing compound applied at joints shall be feathered out to not less than 12 inches wide. After compound has dried, the treated areas shall be sanded as necessary to obtain uniformly smooth surfaces. Care shall be taken not to scuff the paper surface of the wallboard.

**3.1.7 Corner Treatment and Control Joints:**

**3.1.7.1 Internal Corners:** Shall be treated in the manner specified hereinbefore for joints, except that the reinforcing tape shall be folded lengthwise through the middle and fitted neatly into the corner.

**3.1.7.2 External Corners:** Shall have a pre-formed metal corner bead fitted neatly over the corner and secured with the same type fasteners used for applying wallboard. The fasteners shall be spaced approximately 6 inches on centers and driven through the wallboard into the framing member. After the corner piece has been secured in place, the corner shall be treated with joint compound in the manner hereinbefore specified for joints. The joint compound shall be feathered out from 8 to 10 inches on each side of corner.

**3.1.7.3 Control Joints:** Shall be No. 093 type, roll-formed zinc spaced at not more than 35 ft. in any direction.

**3.1.8 Painting:** Gypsum drywall shall be painted in accordance with Division 09900, Painting.

**3.2 Quality Assurance:** The Subcontractor shall establish and maintain his quality control for this section to assure compliance with subcontract requirements and maintain records of his quality control for all construction operations including, but not limited to the items listed below:

Materials including storage and handling.  
Framing and furring including framed opening.  
Application, attachment, corner treatment.  
Joint and fastener concealment.  
Corner treatment.

- 3.3 Shop Drawings:** Shop drawings, manufacturer's descriptive data, and installation details shall be submitted for furring and framing and for framed openings. Shop drawings for fire rated walls and ceilings shall be submitted for approval.
- 3.4 Inspection:** Vertical framing shall be tested with a straight edge both ways to establish that planes are true, plumb and level. Do not cover framing or suspension until it is approved.
- 3.5 Certificate of Compliance:** Certificates attesting that fire rated gypsum boards meet the requirements specified shall be submitted to the RE.

**END OF SECTION**

**SECTION 09660**  
**RESILIENT TILE FLOORING**

**PART 1 - GENERAL**

- 1.1     Scope** - Division includes the following:
  - 1.1.1**   Rubber floor tile.
  - 1.1.2**   Vinyl composition floor tile.
- 1.3     Submittals** - Submit the following in accordance with Contract Documents.
  - 1.3.1**   Product Data for each type of product specified.
  - 1.3.2**   Certification by tile manufacturer that products supplied for tile installation comply with local regulations controlling use of volatile organic compounds (VOC's).
  - 1.3.3**   Samples for initial selection purposes in form of manufacturer's color charts consisting of actual tiles or sections of tiles showing full range of colors and patterns available for each type of resilient floor tile indicated.

**PART 2 - PRODUCTS**

- 2.1     Single-Source Responsibility for Floor Tile** - Obtain each type, color, and pattern of tile from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the work.
- 2.2     Fire Performance Characteristics** - Provide resilient floor tile with the following fire performance characteristics as determined by testing products per ASTM test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 2.2.1   Critical Radiant Flux** - 0.45 watts per sq.cm. or more per ASTM E 648.
  - 2.2.2   Smoke Density** - Less than 450 per ASTM E 662.
- 2.3     Resilient Tile**
  - 2.3.1   Vinyl Composition Floor Tile** - Products complying with ASTM F 1066, Composition 1 (non-asbestos formulated).
- 2.4     Installation Accessories**
  - 2.4.1   Concrete Slab Primer** - Nonstaining type as recommended by floor manufacturer.
  - 2.4.2   Trowelable Underlayments and Patching Compounds** - Latex-modified, Portland-cement-based formulation provided or approved by tile manufacturer for applications indicated.
  - 2.4.3   Adhesives (Cements)** - Water-resistant type recommended by tile manufacturer to suit resilient floor tile products and substrate conditions indicated.



**2.5     Delivery, Storage, And Handling**

- 2.5.1**   Deliver tiles and installation accessories to Project site in original manufacturer's unopened cartons and containers each bearing names of product and manufacturer, project identification, and shipping and handling instructions.
- 2.5.2**   Store flooring materials in dry spaces protected from the weather with ambient temperatures maintained between 50 deg F (10 deg C) and 90 deg F (32 deg C).
- 2.5.3**   Store tile on flat surfaces. Move tiles and installation accessories into spaces where they will be installed at least 48 hours in advance of installation.

**2.6     Contract Spares**

- 2.6.1**   Deliver extra materials to Owner. Furnish extra materials matching products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.
- 2.6.2**   Furnish not less than one box for each 50 boxes or fraction thereof, of each class, wearing surface, color, pattern and size of resilient floor tile installed.

**PART 3 - EXECUTION**

**3.1     Project Conditions**

- 3.1.1**   Maintain a minimum temperature of 70 deg F (21 deg C) in spaces to receive tiles for at least 48 hours prior to installation, during installation, and for not less than 48 hours after installation. After this period, maintain a temperature of not less than 55 deg F (13 deg C).
- 3.1.2**   Do not install tiles until they are at the same temperature as the space where they are to be installed.
- 3.1.3**   Close spaces to traffic during tile installation.
- 3.1.4**   Install tiles and accessories after other finishing operations, including painting, have been completed.
- 3.1.5**   Do not install tiles over concrete slab until the slabs have cured and are sufficiently dry to bond with adhesive as determined by tile manufacturer's recommended bond and moisture test.

**3.2     Examination**

- 3.2.1**   **General** - Examine areas where installation of tiles will occur, with Installer present, to verify that substrates and conditions are satisfactory for tile installation and comply with tile manufacturer's requirements and those specified in this Division.
- 3.2.2**   **Concrete Subfloors** - Verify that concrete slabs comply with ASTM F 710 and the following:
  - 3.2.2.1**   Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials whose presence would interfere with bonding of adhesive. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by tile manufacturer.
  - 3.2.2.2**   Finishes of subfloors comply with tolerances and other requirements specified in Division 03301 "Cast-In-Place Concrete" for slabs receiving resilient flooring.

3.2.2.3 Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits of any kind.

### 3.3 Preparation

3.3.1 General - Comply with manufacturer's installation specifications to prepare substrates indicated to receive tile.

3.3.2 Use trowelable leveling and patching compounds per tile manufacturer's directions to fill cracks, holes, and depressions in substrates.

3.3.3 Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

3.3.4 Broom or vacuum clean substrates to be covered by tiles immediately before tile installation. Following cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

3.3.5 Apply concrete slab primer, if recommended by flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.

### 3.4 Installation

3.4.1 General - Comply with tile manufacturer's installation directions and other requirements indicated that are applicable to each type of tile installation included in Project.

3.4.2 Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths at perimeter that equal less than one-half of a tile. Install tiles square with room axis, unless otherwise indicated.

3.4.3 Match tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered. Cut tiles neatly around all fixtures. Discard broken, cracked, chipped, or deformed tiles.

3.4.3.1 Lay tiles to match existing tile pattern.

3.4.4 Where demountable partitions and other items are indicated for installing on top of finished tile floor, install tile before these items are installed.

3.4.5 Scribe, cut, and fit tiles to butt tightly to vertical surfaces, permanent fixtures, built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.

3.4.6 Extend tiles into toe spaces, door reveals, closets, and similar openings.

3.4.7 Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other nonpermanent marking device.

3.4.8 Install tiles on covers for telephone and electrical ducts, and similar items occurring within finished floor areas. Maintain overall continuity of color and pattern with pieces of flooring installed on these covers. Tightly adhere edges to perimeter of floor around covers and to covers.

- 3.4.9** Adhere tiles to flooring substrates without producing open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections in completed tile installation.
- 3.4.10** Use full spread of adhesive applied to substrate in compliance with tile manufacturer's directions including those for trowel notching, adhesive mixing, and adhesive open and working times.
- 3.4.11** Hand roll tiles where required by tile manufacturer.
- 3.5** **Cleaning And Protection**
  - 3.5.1** Perform the following operations immediately after completing tile installation:
    - 3.5.1.1** Remove visible adhesive and other surface blemishes using cleaner recommended by tile manufacturer.
    - 3.5.1.2** Sweep or vacuum floor thoroughly.
    - 3.5.1.3** Do not wash floor until after time period recommended by resilient floor tile manufacturer.
    - 3.5.1.4** Damp-mop tile to remove black marks and soil.
  - 3.5.2** Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by tile manufacturer.
    - 3.5.2.1** Apply protective floor polish to tile surfaces that are free from soil, visible adhesive, and surface blemishes. Use commercially available, metal, cross-linked acrylic product acceptable to tile manufacturer. Coordinate selection of floor polish with Owner's maintenance service.
    - 3.5.2.2** Cover tiles with undyed, untreated building paper until inspection for Substantial Completion.
    - 3.5.2.3** Do not move heavy and sharp objects directly over tiles. Place plywood or hardboard panels over tiles and under objects while they are being moved. Slide or roll objects over panels without moving panels.
  - 3.5.3** Clean tiles not more than 4 days prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean tiles using method recommended by manufacturer.
    - 3.5.3.1** Strip protective floor polish that was applied after completing installation prior to cleaning.
    - 3.5.3.2** Reapply floor polish after cleaning.

**END OF SECTION**



**SECTION 09678**  
**RESILIENT COVE BASE**

**PART 1 - GENERAL**

**1.1**     **Scope** - Provide and install resilient cove wall base wherever resilient tile flooring is installed.

**1.2**     **Applicable Documents**

Federal Specification (FS) SS-W-40A Wall Base; Rubber, and Vinyl Plastic

**PART 2 - PRODUCTS**

**2.1**     **Materials**

**2.1.1**   Vinyl wall base shall conform to FS SS-W-40, Type I or Type II, Style B, and be provided by same manufacturer as resilient tile flooring.

**2.1.2**   Base shall be 4 inches high, minimum 0.080 inch thick, color as selected from manufacturer's standard colors.

**2.1.3**   Internal and external corners shall be pre-molded type.

**2.1.4**   Adhesive for wall base shall be as recommended by the base manufacturer.

**2.2**     **Submittals** - The Contractor shall submit manufacturer's catalog cuts of vinyl wall base and chart of manufacturer's standard colors for approval and color selection.

**PART 3 - EXECUTION**

**3.1**     **Installation** - Vinyl wall base shall be installed in adhesive in accordance with the approved installation instructions of the manufacturer.

**3.2**     **Craftsmanship** - Work shall be performed by a worker skilled in this type of work.

**END OF DIVISION**

**SECTION 09900**  
**PAINTING**

**PART 1 - GENERAL**

**1.1 Work Included:**

- A. **Exterior Painting:** Includes all surfaces of the building and appurtenances as indicated. Included are existing coated surfaces made bare by cleaning operations.
- B. **Interior Painting:** Includes all surfaces of the building and appurtenances. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise:
- C. **Mechanical and Electrical Painting:** Includes field coating of interior and exterior surfaces.
- D. **Non-specific Surfaces:** Where a space or surface is not specifically indicated to be painted, include the following items unless directed otherwise:
  - 1. Exposed piping, conduit, and ductwork;
  - 2. Supports, hangers, air grilles, and registers;
  - 3. Miscellaneous metalwork and insulation coverings.
  - 4. Cable trays.
  - 5. New zinc-coated strut systems including all-thread rods.
- E. **Painting Included:** Where a space or surface is indicated to be painted, include the following unless indicated otherwise:
  - 1. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.
  - 2. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.
  - 3. Existing coated surfaces that are damaged during performance of the work.
- F. **Painting Excluded:** Do not paint the following unless indicated otherwise:
  - 1. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.
  - 2. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.
  - 3. New zinc-coated, aluminum, and copper surfaces under insulation;
  - 4. New aluminum jacket on piping; and
  - 5. New interior ferrous piping under insulation.

**1.4 Submittals:** Submittals shall be in accordance with Contract Documents and shall include:

- A. **Color Charts:** Manufacturer's color chips and charts for use in preparation of color schedule.
- B. **Manufacturer's Instructions**
- C. **Paint application instructions**
- D. **MSDS:** Submit Manufacturer's Material Safety Data Sheets (MSDS) for coatings, solvents, and other potentially hazardous materials.

- 1.5 Delivery And Storage:** Deliver materials in sealed, labeled containers bearing the manufacturer's name, brand designation, specification number, batch number, color, and date of manufacture. Restrict storage and mixing of materials to locations designated by the RE. Products shall be stored in an approved ventilated dry area, protected from contact with soil and from exposure to the elements. Keep products dry at all times.
- 1.6 Handling:** Handle packaging and containers in a manner that will prevent damage to contents.
- 1.7 Identification of Materials:** Containers shall have labels with the following information:
- Manufacturer's name
  - Type of paint
  - Color
  - Manufacturer's stock number
  - Instructions for reducing, where applicable
- 1.8 Quality Assurance:**
- A. Sample Area:** A test area of wall surface from 5 to 10 square feet in size shall be cleaned with the specified material, in accordance with the manufacturers instructions, for the approval of the RE.
- B. Inspection and Acceptance:** In addition to meeting the previously specified requirements, demonstrate the mobility of moving components, including but not limited to swinging doors and cabinets, for inspection by the RE. Perform this demonstration after appropriate curing and drying times of the coatings have elapsed and prior to invoicing for final payment.

## **PART 2 - PRODUCTS**

- 2.1 General:** To the maximum extent practicable, use the materials of one manufacturer throughout the project. Primer shall be of suitable type for each surface and compatible in each case with the finish paint.
- 2.2 Materials Lists:** The following products or an approved equal shall be used. Paint other than those listed shall be manufacturer certified that they are of equal or better quality than those listed.
- A. Galvanized Metal Primer:**
- |                                  |                  |
|----------------------------------|------------------|
| No. 850A1 Galvanized Iron Primer | Sherwin-Williams |
|----------------------------------|------------------|
- B. Metal Primer:**
- |  |                     |
|--|---------------------|
| Rust-O-Lastic, No. 24-R-5                  | M. A. Bruder & Sons |
| Kem Kromik, No. B-50-N-2                   | Sherwin-Williams    |
| Rust-O-Lastic Zinc Dust Primer No. 073-218 | M. A. Bruder & Sons |
- C. Exterior Ferrous Metal Paint:**
- |                              |                  |
|------------------------------|------------------|
| Dulux Metal Protective Paint | Dupont           |
| Metalastic Paint             | Sherwin-Williams |
| Noxide Metal Paint           | Pratt & Lambert  |
- D. Enamel Undercoat:**
- |  |        |
|--|--------|
| No. 853 Dulux Ovalite Enamel Undercoat | Dupont |
|--|--------|



Vitralite Enamel Undercoat  
P. C. Enamel Undercoat

Pratt & Lambert  
Sherwin-Williams

**E. Interior Enamel:**

No. 299 Dulux Enamel Eggshell Sheen  
Rich-Lux Low Lustre Alkyd Enamel 021  
Pro Mar Eggshell Enamel Series B33

Dupont  
M. A. Bruder & Sons  
Sherwin-Williams

**F. Exterior Flat Wall Paint:**

Weather Perfect Acrylic Latex  
PPG Exterior Acrylic Latex  
Acra-Lastic Acrylic

Sherwin-Williams  
Pittsburgh Paints  
M. A. Bruder & Sons

**G. Enamel (Epoxy Resin) Semi-Gloss:**

Tile-Clad II Enamel  
Aquapon  
Glid Guard Y-5240/Y5242

Sherwin-Williams  
Pittsburgh Paints  
Glidden

**H. Interior Latex Flat Paint:**

Pro-Hide-Plus  
Pro Mar 200, Series B30 W200  
Wonder Speed 506XX

Pratt and Lambert  
Sherwin-Williams  
Devoe Paint

- 2.3 Evidence of Acceptable Variation:** If a product proposed for use does not conform to requirements of the referenced specification, submit for approval to the RE, evidence that the proposed product is either equal to or better than the product specified.
- 2.4 Color Selection:** Colors of finish coats shall be as indicated or specified. Where not indicated or specified, colors shall be selected by the RE in coordination with FAA. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors approximate colors indicated and the product conforms to specified requirements.

**PART 3 - EXECUTION**

- 3.1 Environmental Requirements:** Paint shall not be applied to unprotected surfaces in wet weather nor to surfaces on which ice, frost, water, or dampness is visible. Paint shall not be applied in rain, wind, snow, fog or mist nor when the steel surface temperature is below the dew point, resulting in condensation or moisture. When paint is applied in hot weather or thinned in cold weather, ensure that the specified thickness of paint coating is obtained. Do not apply exterior paint in damp, rainy weather nor until the surface has dried thoroughly from the effects of such weather. The temperature of the surface to be painted and of the surrounding air temperature shall be maintained between 45° and 95° F during the application and drying period. Surfaces shall be dry before paint is applied. Surface to be painted shall be clean, dry, smooth and adequately protected from dampness.
- A. Exterior Paint:** Exterior paint shall not be applied when the temperature is lower than 40° F or expected to fall below this temperature. Interior paint shall not be applied when the temperature is lower than 60° F or expected to fall below this temperature.

- B. **Interior Paint:** Interior paint shall not be applied when, in the RE's opinion, satisfactory results cannot be obtained due to high humidity and excessive temperature; however, failure of the RE to notify the Subcontractor of the conditions will not relieve the Subcontractor of responsibility to produce satisfactory results.
- C. **Metallic Surfaces:** Do not paint steel which is at a temperature which can cause blistering, porosity, or otherwise be detrimental to the life of the paint.

### 3.2 **Preparation**

- A. **Mounted Hardware:** Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixture, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials to original condition and repair damaged items.
- B. **Surfaces:** Surfaces shall be inspected in regard to their suitability to receive a finish. In the event that imperfections due to materials or workmanship appear on surfaces, appropriate corrections shall be made at no additional cost to the Government. Remove dirt, splinters, loose particles, grease, oil, and other substances deleterious to coating performance as specified for each substrate.
- C. **Protection:** Products and materials placed prior to painting shall be removed or protected. Remove protection upon completion of painting.
- D. **Cleaning of Surfaces:** Surfaces to be painted shall be cleaned as required to remove dust and dirt.
  - 1. **Cleaning Ferrous Surfaces** - Ferrous surfaces, interior and exterior, that have not been shop-coated shall be solvent-cleaned to remove oil and grease, then mechanically cleaned by power wire-brushing or blast cleaning to remove loose rust, loose mill-scale and other foreign substances. Blast cleaning shall conform to Steel Structures Painting Council Specification SSPC-SP-6 for commercial sandblasting. Power tool cleaning shall conform to Steel Structures Painting Council Specification SSPC-SP-3. Cleaning shall be scheduled to permit priming of the cleaned areas on the same day. In the event the cleaned surfaces are left unprimed until the formation of corrosion, the affected areas shall be cleaned again. Minor amounts of residual rust that cannot be removed except by white metal blast-cleaning, and tight mill-scale that cannot be removed by applying a sharp knife to any edge, will be permitted. After cleaning, one coat of paint shall be applied to a minimum dry film thickness of 1 mil. Shop-coated metal shall be protected from corrosion before and after installation by treating corroded areas immediately upon detection. Rust spots, and spots where shop coat has been abraded, shall be sanded to bright metal and recoated with a primer.
  - 2. **Fabricated and Assembled Items** - Fabricated and assembled items which are normally cleaned and primed in accordance with the manufacturer's standard practice may be exempted from the requirements for surface preparation and first coat specified in Chapter 9 or on the drawings upon specific request by the Subcontractor and approval by the Subcontract Administrator. Similarly, items which are normally painted with a complete coating system in accordance with the manufacturer's standard practice may be exempted entirely from the surface preparation and painting requirements herein, provided the finish coat is of acceptable color and quality and is touched up as necessary in the field. Requests for exemption shall be accompanied by a description of the manufacturer's standard coating including surface preparation, type of paint, dry film thickness and whether baked or air-dried.
  - 3. **Nonferrous Metal Surfaces** - All nonferrous metal surfaces, such as aluminum alloy (except anodized), copper, zinc-copper-alloy, and zinc-coated surfaces, including



nonferrous surfaces not to be painted, shall be solvent-cleaned as necessary to remove all oil, grease or other foreign substances. After cleaning, all nonferrous surfaces to be painted shall be treated with vinyl type wash coat as hereinafter specified. Painting to protect aluminum from contact with dissimilar materials should be specified under the division of the specification covering the specific item. All zinc-coated metal shall be protected from corrosion before and after installation by treating cut, scarred, corroded, or abraded spots immediately upon detection. Such spots shall be thoroughly wire-brushed, cleaned and smoothed, treated with vinyl wash coat or primed with zinc dust or zinc dust-zinc oxide metal primer, and then painted when necessary with a finish color coating which will match the color of adjoining surface.

4. Gypsum Board - Gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush or rubbing with a dry cloth prior to application of the first coat material. Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with spackling compound and sand smooth.
5. Preparation of Wood and Plywood Surface
  - a. Surface Cleaning - Surfaces shall be free from dust and other deleterious substances and in a condition approved by the RE prior to receiving paint or other finish. Do not use water to clean uncoated wood.
  - b. Removal of Fungus and Mold - Wash existing coated surfaces with a solution composed of 3 ounces (2/3 cup) trisodium phosphate, 1 ounce (1/3 cup) household detergent, 1 quart 5% sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.
  - c. Prime Coat for Exterior Surfaces - Prime coat before wood becomes dirty, warped, or weathered.
  - d. Cracks and Nailheads - Set and putty stop nailheads and putty cracks after the prime coat has dried.

- E. Touch-Ups: Scratches, abrasions or other disfigurements shall be properly prepared and touched-up. Remove foreign matter from prime coats before proceeding with subsequent coats. Spot priming shall be feathered into adjacent coatings to produce a smooth and level surface.

### 3.3 Application

- A. Prime Coat: Miscellaneous metal, hollow metal doors and frames, and other materials which have been prime coated shall be touched-up where the shop coat has been damaged by welding or abrasion during the handling and erection operations. Touch-up primed fasteners and welds which are unpainted after assembly and erection.
- B. Coating Application: Thoroughly work coating materials into joints, crevices, and open spaces. Touch up damaged coating before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.
  1. Drying Time - Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying. Provide each coat in specified condition to receive next coat.
  2. Primers and Intermediate Coats - Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by the manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coats. Each coat shall cover the surface of the preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.
  3. Finished Surfaces - Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.
- C. Paint Utensils: Paint shall be applied by a brush, roller or spray in accordance with the manufacturer's directions. Use the type of brushes best suited for the type of materials being



applied. For covers on rollers use carpet with velvet back and of high pile sheep's wool or use short hair covers, as best suited for material specified.

- D. **Thinning of Paints:** Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory for the type of paint being used. Obtain written permission from the RE to use thinners. The written permission shall include quantities and types of thinners to use.
- E. **Minimum Dry Film Thickness (DFT):** Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise. Coating thickness where specified, refers to the minimum dry film thickness.
- F. **Coatings for Surfaces not Specified Otherwise:** Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.
- G. **Existing Surfaces Damaged:** During performance of the work, including new patches in existing surfaces, coat surfaces with the following:
- One coat of primer.  
One coat of undercoat or intermediate coat.  
One top coat to match adjacent surfaces.
- H. **Paint Techniques:** Each coat of paint shall be applied smoothly, worked out evenly and allowed to dry completely before the subsequent coat is applied. Finished work shall be uniform and of the specified color. Paint shall completely cover, be smooth and free from runs, sags, clogging or excessive flooding. Make edge of paint adjoining other materials or colors sharp and clean without overlapping. Where high gloss enamel is used, lightly sand undercoat to obtain a smooth finish coat. Painting shall be completed according to the manufacturer's written instructions. Apply spray paint uniformly with suitable equipment. Paint shall be applied to a minimum dry film thickness of five mils. Tint each coat of paint slightly lighter or darker than the preceding coat or the finish coat.
- I. **Commencement:** Painting shall commence when other operations detrimental to finish painting have been completed and the areas have been approved for painting.
- J. **Precautions:** Soiled cleaning rags and waste shall be disposed of daily at the close of each day's work or stored in metal containers with tight fitting covers. An appropriate number of sand buckets shall be provided at all times for use in the event of fire. "No Smoking" signs shall be posted as required or directed.
- K. **Exterior Ferrous Metal Surfaces:** Hollow metal doors and frames; metal wall panels; handrails

1st Coat	Galvanized metal primer
2nd Coat	Exterior ferrous metal paint
3rd Coat	Exterior ferrous metal paint

- L. **Interior Surfaces**  
1. Gypsum Board

1st Coat	Latex wall primer
2nd Coat	Latex flat
3rd Coat	Latex flat

2. Ferrous Metal - Structural steel, hollow metal doors and frames (Dark Brown), galvanized metal conduit, underside of galvanized metal deck, exposed metal plates, angles, shapes, hangers, and dampers shall be painted as follows:

1st Coat	Metal primer (if not shop primed)
1st Coat (galvanized)	Galvanized metal primer
2nd Coat	Enamel undercoat
3rd Coat	Enamel

- 3.4 Final Cleaning:** Upon completion of work, remove staging, scaffolding and containers from the site. Remove paint spots, oil or stains from floors and other surfaces not to be painted, and leave facility clean and acceptable to the RE.

**END OF SECTION**

**SECTION 09901**  
**REPAIRING DAMAGED HOT-DIP GALVANIZED COATING**

**PART 1 – GENERAL**

- 1.1**     **Scope:** Excessively damaged items, as determined by the CET, shall be returned to the supplier for regalvanizing.
- 1.1.1**   When approved in writing by the CET, hot-dip galvanized coatings shall be repaired in accordance with this division of the specifications.
- 1.2**     **Applicable Documents:** ASTM A 780-80 Standard Practice for Repair of Damaged Hot-Dip Galvanized Coatings
- 1.3**     **Submittals:** Submit manufacturer's product literature.

**PART 2 – PRODUCTS**

- 2.1**     **Material:** All damaged hot-dip galvanized coatings of reamed or field drilled holes shall be repaired using a zinc-rich paint. As a minimum, the zinc-rich paint dried film shall contain 94% zinc dust by weight and conform to ASTM A780-80.
- 2.1.1**   **Coat Thickness:** 3 Mils Minimum (Dry Film)
- 2.1.1.1** The following product, or approved equal, may be used:  
  
          Z.R.C. – Liquid cold galvanizing compound with shiny finish by "ZRC Products Comp.", Quincy MA, (617) 773-1180.

**PART 3 – PRODUCTS**

- 3.1**     **Surface Preparation**
- 3.1.1**   Surfaces to be reconditioned shall be clean, dry, and free of oil, grease, and corrosive products.
- 3.1.2**   Surface preparation shall be in accordance with ASTM A780, ANNEX A2, AWS C2.2-67 and product manufacturer specifications.
- 3.1.3**   To ensure a smooth coating, surface preparation shall extend into the undamaged galvanized coating. The method and extent of the surface preparation shall be approved by the CET.
- 3.2**     **Application:** Apply coatings as recommended by the manufacturers and listed specifications.
- 3.3**     **Quality Assurance:** Dry film thickness shall be measured, at locations selected by the CET, using a magnetic or electromagnetic gauge. All measurements shall be taken in the presence of the CET and recorded.
- 3.3.1**   Resurface rejected areas as required.

**END OF SECTION**



**SECTION 15000**  
**MECHANICAL - GENERAL**

**PART 1 - GENERAL**

- 1.1     Work Included** - Except as modified in this Division, applicable provisions and requirements and other contract documents apply to work in all Mechanical Divisions of this specification, including Divisions 15000, 15200, 15300, 15400, and 15600.

**1.2     Scope of Work**

- (1) Contractor shall furnish and install two (2) self-contained (packaged) wall-mounted air conditioning units and one (1) wall mounted electric heaters, including all controls, accessories and components as specified and shown on the drawings and as required to provide a complete and operable air conditioning and heating system.
- (2) Contractor shall furnish and install ventilation systems, including all fans, intake/exhaust hoods, dampers, controls and other work as specified and shown on the drawings and as required to provide a complete and operable ventilation system.
- (3) Contractor shall furnish and install R-19 fiberglass insulation with vapor barrier in the ceiling and the equipment room walls.
- (4) Contractor shall install the Government-Furnished engine generator, muffler and other items as indicated on drawings. Contractor shall furnish and install fuel storage tank, exhaust piping and fuel piping including fittings, valves, flanges, reducers, wall sleeves, insulation, hangers, pipe supports, controls, electrical wiring, conduit and other work as specified and shown on the drawings and as required to provide a complete and operable engine generator system.

- 1.3     Mechanical Divisions** - Mechanical divisions of this specification shall include the following:

15000 Mechanical – General  
15200 Air Conditioning System  
15300 Propane Engine Generator System  
15400 Aboveground Propane Storage Tank  
15600 Ventilating Systems

- 1.4     Applicable Documents** - The current issues of the following documents in effect on the date of the Request-for Proposal form a part of this specification and are applicable to the extent specified herein.

**1.4.1     American Concrete Institute (ACI)**

301             Structural Concrete for Buildings  
318             Building Code Requirements for Reinforced Concrete

**1.4.2     American Society for Testing and Materials (ASTM)**

A53             Pipe, Steel, Black and Hot-Dipped Zinc Coated Welded and Seamless  
A120             Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized)  
D2996           Filament-Wound Reinforced Thermosetting Resin Pipe

**1.4.3 American National Standards Institute (ANSI)**

ANSI B1.20.1 1983, Pipe Threads, General Purpose  
ANSI B16.3 1985, Malleable Iron Threaded Fittings  
ANSI B16.39 1986, Malleable Iron Threaded Pipe Unions, Classes 150, 250 and 300  
ANSI Z21.69 1987, Connectors For Moveable Gas Appliances

**1.4.4 American Society of Heating, Refrigerating, and Air Conditioning Engineers**

ASHRAE Handbook, Equipment Volume

**1.4.5 Air Movement and Control Association**

AMCA Standards

**1.4.6 Federal Specifications**

CC-M-187 Motor, Alternating Current, Fractional and Integral Horsepower (500 hp and smaller)

**1.4.7 National Fire Protection Association (NFPA)**

NFPA 30 Flammable and Combustible Liquids Code  
NFPA 37 Stationary Combustion Engines and Gas Turbines  
NFPA 58 Standard for the Storage and Handling of Liquefied Petroleum Gases  
NFPA 70 National Electrical Code  
NFPA 110 Emergency and Standby Power System  
NFPA 329 Underground Leakage of Flammable and Combustible Liquids

**1.4.8 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)**

SMACNA Low and High Pressure Duct Construction Standards

**1.5 Acronyms**

CET-Construction Engineering Technician  
CFM-Contractor Furnished Materials  
COR-Contracting Officer's Representative  
E/G-Engine Generator  
GFM-Government Furnished Materials  
NEC-National Electrical Code  
NFPA-National Fire Protection Association  
OSHA-Occupational Safety and Health Administration  
RE-Resident Engineer  
SOW-Statement of Work

**1.6 Space Conditions**

- 1.6.1 Existing Conditions** - The drawings indicate certain information pertaining to existing conditions, including equipment and other work, which has been taken from available drawings. Such information is not guaranteed as to its accuracy and completeness. The Contractor shall verify all existing conditions at the site prior to commencement of work. Verify location of all utilities prior to excavation and trenching. Contractor shall be responsible for restoration of all utilities at no additional cost to the Government.

- 1.6.2 Indoor Work** - All work inside the building shall proceed in such a manner as to minimize the effect on all FAA operations, and shall protect the delicate electronic equipment inside the building. Contractor shall take all actions necessary to minimize the spread of dust and flying particles.
- 1.6.3 Piping and Equipment** - All equipment, piping and materials must be introduced into the building in such manner as not to cause damage to any equipment or the structure. All apparatus shall be installed essentially as shown on the drawings. Any changes of layout due to variations in configuration of apparatus must be accomplished at no additional cost to the Government.
- 1.6.4 Accessibility** - All equipment and components normally requiring operation, service or maintenance within the life of the system shall be made readily accessible.
- 1.6.5 Dimensions** - The Contractor, before commencing work, shall verify all dimensions at the site.
- 1.7 Cutting and Repairing** - Contractor shall perform all cutting and repairing necessary for installation of specified work. Where any existing work is removed by Contractor, surfaces exposed by such removal shall be repaired, painted and/or otherwise finished as required to match existing adjacent work. Structural members shall not be cut unless specifically so shown or noted on drawings, or authorized by the FAA.
- 1.8 Shop Drawings**
- 1.8.1 Submittals** - Before any equipment is ordered or material fabricated, five (5) copies of shop drawings and manufacturer's complete performance and descriptive data shall be submitted to and approved by the FAA and Broward County Aviation Department. All manufacturer's data and shop drawings shall be submitted in loose-leaf binders. In the interest of expediting approval and eliminating unnecessary confusion, it is recommended that all materials be made at one time and in one package. Manufacturer's performance and descriptive data shall be submitted on all new equipment and materials, including but not limited to:

<u>NO.</u>	<u>ITEM</u>
(1)	Air Conditioning Units
(2)	Grilles, registers and dampers
(3)	Piping, fittings, valves and supports
(4)	Pipe insulation
(5)	Exhaust fans
(6)	Intake/exhaust hoods
(7)	Intake/exhaust dampers
(8)	Fuel storage tank
(9)	Air filters
(10)	Automatic controls
(11)	Unit heaters
(12)	Ductwork

- 1.8.2 Approval** - Approval of shop drawings, or other data submitted in accordance with submittal requirements, does not ensure that the Contractor Administrator attests to the performance or dimensional accuracy and suitability of the equipment or material. Neither does approval invalidate the plans and specifications if in conflict unless a letter requesting such change is submitted and approved.

## **PART 2 - PRODUCTS**

### **2.1 Equipment and Materials**



- 2.1.1 Quality** - All equipment and materials (other than existing which is to be reused) shall be as specified herein. They shall be new and free from all defects and imperfections that might affect the serviceability of the finished product.
- 2.1.2 Type Products Manufacturer** - All new equipment of one type shall be the product of one manufacturer.
- 2.2 Government Furnished Materials (GFM)**
- 2.2.1 General** - Government Furnished Materials, (GFM), will be as described in the Statement of Work (SOW) and as shown on the drawings.

### **PART 3 - EXECUTION**

#### **3.1 Guarantees**

- 3.1.1** Contractor shall guarantee that if any workmanship or material required by this project proves defective or any part of the installation fails to perform as specified, Contractor shall remedy such defects without expense to the Government for service, materials, parts and labor, for a period of one year after final settlement.
- 3.1.2** Contractor shall provide air conditioning units on which the manufacturer has provided full 5-year warranties on all compressors. Such warranties shall commence upon date of Joint Acceptance Inspection (JAI) of air conditioning system by the Government, and three (3) written copies shall be furnished to the RE.

#### **3.2 Utilities**

- 3.2.1** Before starting any other work on this project, the Contractor shall verify the exact location of all existing utilities to which he is to make connections for this project. If for any reason, conditions should appear that will adversely affect the proper installation and operation of the systems required for this project, such conditions shall be reported to the RE in writing for his decision.
- 3.2.2** All expenses for connections, extensions, temporary services, cutting and patching of paving, trenching, backfilling and all other work required for installation and connection to the various utility lines, shall be included in the Contractor's bid price.
- 3.2.3** All materials and method of installation shall be in accordance with the National Plumbing Code, National Electrical Code, National Fire Protection Association, FAA electrical specifications, municipal codes, requirements of local utility companies and any other authorities that may have lawful jurisdiction pertaining to any portion of this project.
- 3.2.4** The Contractor shall procure all necessary permits, licenses and inspections required to accomplish his work and shall pay the lawful fees therefore.

#### **3.3 Storage and Protection of Materials**

- 3.3.1** Contractor shall be responsible for the transportation of his materials to and from the job. All storage space locations shall be subject to approval of the RE prior to use for storage of equipment or materials.
- 3.3.2** Pipe, fittings and other materials stored outside the building (or inside the building prior to building being weathered in) shall be subject to approval of the RE prior to use for storage of equipment or materials.

- 3.3.3** All materials, equipment and other work, whether incorporated in the building or not, shall be protected at all times against the weather (rain, wind, frost, ice or heat) so as to maintain such work free from possible damage. At the end of each workday, all work likely to be subject to damage from weather shall be covered.
- 3.3.4** All equipment, piping, insulation or other work, which is damaged, abused or otherwise harmed by weather or workmen during life of this contract shall be replaced or repaired by the Contractor as directed by the RE at no additional cost to the government.
- 3.3.5** All openings provided in building roof and exterior walls shall be provided with temporary watertight covers, until such time as openings have been repaired or equipment required for such openings, has been installed.
- 3.4** **Start-Up** – The Contractor shall provide a start-up technician certified by the air conditioning equipment manufacturer, and shall also provide a one-year parts and labor warranty on the entire mechanical installation. The start-up technician shall be a certified manufacturer's technician employed by the manufacturer's local distributor office and all work shall be done in accordance with Section 608 of the Clean Air Act.

**END OF SECTION**



**SECTION 15200**  
**AIR CONDITIONING SYSTEM**

**PART 1 – GENERAL**

- 1.1 **Work Included** - Reference Division 15000 – Mechanical-General, for general requirements applicable to this division.
- 1.2 **Scope** – This division of the specification includes the furnishing of a complete and operable air conditioning system as described herein and indicated on the drawings.

**PART 2 – PRODUCTS**

- 2.1 **General** - The contractor shall furnish and install complete two (2) self-contained, electrically controlled, energy efficient air conditioning units. The air conditioning units shall be wall mounted for horizontal indoor airflow. The units shall deliver not less than the cooling capacity and supply air quantities as specified on the drawings with the manufacturer's data rated and certified in accordance with ARI Standards 210 and 270. Units shall be UL listed and labeled. Units shall be completely factory assembled, piped, internally wired, fully charged with R-410a refrigerant, and run tested and as a minimum shall include refrigerant circuits, evaporator coil, condenser coil, evaporator fan, condenser fan, compressor, return air filter, air filter frame, refrigerant piping, condensate drain, insulated cabinet, equipped with a "J" control module, and all associated unit controls and wiring. The contractor shall furnish and install all options and accessories specified when items are not available from the manufacturer. The units shall be as manufactured by Bard Manufacturing Company. See drawings for model numbers.
- 2.2 **Unit Cabinets** - Cabinets for units installed outdoors shall be fully weatherproofed and suitable for outdoor installation. All components of the units shall be enclosed inside a zinc-coated heavy gauge (minimum 20 ga.) weatherproof steel unit casing. Cabinets shall be equipped with removable panels properly sized and located to permit easy access to all components including filters. Cabinets shall have factory applied prime coats of baked enamel finish prior to assembly. The casing shall be factory insulated with minimum 1/2" thick, odorless, insulation to prevent condensation and minimize noise level. The insulation shall be fireproofed in accordance with NFPA standards. To prevent condensate from collecting inside, the cabinets shall include a factory installed condensate drain channel with piping connection. The drain pan shall be coated with corrosion resistant material. Unit shall be designed for horizontal discharge and return. Openings shall be provided for power connections. Access openings/panels to all fan motors and compressor are required, for making repairs and removal of internal components, without removing unit from its permanent installation.
- 2.3 **Refrigerant Coils** - Evaporator and condenser coils shall be of nonferrous construction aluminum plate fins mechanically bonded to seamless copper tubes with all joints brazed. Both the evaporator and the condenser coils shall have phenolic coating for salt and chemical protection. The evaporator coil shall be leak and pressure tested to at least 200 psi and condenser coil to at least 450 psi. The condenser coil shall be adequately protected from the weather to include rain, wind, and hail and, as a minimum, include a rubber or vinyl coated metal grille with less than 1/4 in. openings.
- 2.4 **Indoor Fan and Motor** - The twin evaporator coil blower shall be double inlet, forward-curved, centrifugal, direct drive type, statically and dynamically balanced, capable of operating at air quantity indicated on the drawings. The evaporator blower motor shall be multi-speed with permanently lubricated bearings and built-in automatic-reset thermal overload protection.
- 2.5 **Outdoor Fan and Motor** - The condenser fan shall be direct drive propeller type, statically and dynamically balanced. The condenser fan motor shall be enclosed and weather proof with permanently lubricated bearings and built-in automatic-reset thermal overload protection. The



condenser fan, motor and shroud shall be of "slide out" configuration for easy service and maintenance.

- 2.6 **Compressors** - All compressors shall be fully welded hermetic type and high efficiency. Each compressor shall be equipped with service valves, suitable vibration isolators, crankcase heaters (except scroll compressors), and internal protection from over-currents, high temperatures, and high pressures. Each compressor shall be equipped with an automatic reset relay timer circuit to prevent restart within five (5) minutes after interruption of compressor power for any reason, i.e. safety devices, thermostat, or commercial power failure. All compressors shall have a minimum five-year warranty, manufactured by Copeland, or equal.
- 2.7 **Electric Heaters** - Electric heaters shall be wall mounted unit heaters. See drawings for additional requirements and locations.
- 2.8 **Low Ambient Control** - Units shall be equipped with a fully automatic factory installed and wired low ambient head pressure control system. The control shall protect against evaporator icing and allow mechanical cooling down to 0° F.
- 2.9 **Rain Protection** - The panel of unit should be sloped away from the building to provide "rain hood" protection. Top rain flashing shall be included to minimize water leaks.
- 2.10 **Structural Support** - Units shall include a rigid base rail for rigging, handling, and providing additional structural support. Provide optional lifting lugs or brackets if necessary.
- 2.11 **Mounting Brackets** - Full-length side mounting brackets shall be an integral part of the cabinet. 16 gauge metal bracket shall be provided for the bottom.
- 2.12 **Caging** - Each of the units shall be provided with protective caging with aluminum framing as indicated on the drawings.
- 2.13 **Manufacturers** - The air conditioning units shall be the product of a manufacturer regularly engaged in the production of units of type and size specified who issues complete catalog data. Units shall be Bard Manufacturing Company, or approved equal.
- 2.14 **Air Filters**
- 2.14.1 **General** - The contractor shall furnish and install filters as required. Air filters of uniform size in multiples to cover entire air opening, shall be installed in a filter frame, arranged to slide out through a side access door, and fit snugly to prevent air bypass. The contractor shall coordinate equipment installation to prevent obstructions, which might interfere with filter removal. Upon completion of testing and acceptance of the system by the RE, tested filters shall be replaced with clean new air filters along with two (2) additional spare sets of new air filters for future use by the FAA.
- 2.14.2 **Filter Frame Rack** - Frames shall be fabricated of minimum 16 gauge galvanized steel. Frame shall be designed to accept standard two (2) inch disposable pleated filters. Filter assembly shall be in accordance with SMACNA standards.
- 2.14.3 **Filters** - Filters shall be two (2) inch thick medium efficiency, pleated disposable type. Each filter shall consist of a non-woven cotton fabric media, media support grid and enclosing frame. Filter media shall have a minimum average efficiency of 30% and arrestance rating of 92% per ASHRAE Test Standard 52. Initial resistance at 250 fpm velocity shall not exceed 0.10" wg.
- 2.15 **Outside Air** - Outside air is not required and shall be blanked off.

### **PART 3 - EXECUTION**

- 3.1     Installation** - Air conditioning units shall be securely anchored to the wall to resist all loading conditions to include static and dynamic loads and 140 MPH wind load. The units shall be transported, stored, lifted, and handled in accordance with the manufacturer's protection recommendations.
- 3.2     Painting**
- 3.2.1** HVAC equipment shall be factory painted with anti-corrosive coating. Applicable color selection will be as indicated in the purchase order and/or on the drawings. All other new work shall be field painted by the contractor with zinc oxide primer and finish coats of exterior oil base paint. As many coats of paint shall be applied as required to completely cover all contrasting colors.
- 3.2.2** Finish color of field painted work shall match that of adjacent building surfaces, unless otherwise specified.
- 3.2.3** Upon completion of work, all abrasions, scratches, or other damage to factory or field painted surfaces shall be touched up as required for finish of all work to be equivalent to that of new factory applications.
- 3.2.4** Nameplates, plated or polished surfaces, galvanized stainless steel surfaces, concrete foundations, copper pipes, and aluminum surfaces of housings and grilles shall not be field painted.
- 3.3     Identification** - Each packaged air conditioning unit with thermostat shall have approximately 2 inch high by 4 inch wide black laminated nameplate designating its use. Lettering shall be white and 3/8 inches high. Obtain approval on lettering from the RE prior to engraving. Nameplates shall have beveled edges and mounted to equipment with two-chrome-plated oval head screws.
- 3.4     Wiring** - Refer to Division 16 - Electrical.
- 3.5     Exterior Wall Penetrations** - All exterior wall penetrations shall be sealed watertight.
- 3.6     Quality Assurance**
- 3.6.1   Testing and Adjustments**
- 3.6.1.1** All equipment shall be adjusted so that it will perform as specified and shown on the drawings.
- 3.6.1.2** Capacities of the HVAC system shall be determined by operating and performance test under simulated heat rejection of electronics and electrical power systems to be installed. Contractor shall be responsible for providing temporary electrical resistant heat and power to simulate cooling loads if outdoor conditions are not comparable to design. Coordinate with FAA representative (RE) to make this determination. Test procedures shall be in accordance with applicable portions of SMACNA, NEEC, or AABC.
- 3.6.1.3** Capacities shall be based on temperatures and air quantities measured during such tests.
- 3.6.1.4** Air quantities may be measured by pitot tube, anemometer, or velometer, depending on the velocity and other conditions of flow.
- 3.6.1.5** All labor and instruments required for tests shall be furnished by the contractor. If gauges, thermometers, etc., which are to be left permanently installed are used for tests, they shall not be installed until just prior to the tests to avoid possible changes in calibration.

- 3.6.1.6** Re-adjustment necessary to accomplish the specified results during the first year of operation shall be made without cost to the Government.
- 3.7** **Test Data** - Upon completion of installation, the contractor shall test the HVAC under the supervision of the RE and obtain the data requested in the attached forms. All tests shall be made prior to final inspection and test data sheets shall be furnished in duplicate. All tests shall be made with HVAC equipment operating at full. The contractor shall sign all data sheets and obtain signature of RE witnessing the test. Contractor shall replace all air filters upon completion of testing.

(Installation Test Data Sheets Follow)



**INSTALLATION TEST DATA**

**AIR CONDITIONING UNIT # \_\_\_\_\_**

Manufacturer: \_\_\_\_\_

Model Number: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

Weather Conditions: \_\_\_\_\_

Outdoor Air Temperature: \_\_\_\_\_ °F db \_\_\_\_\_ °F wb

UPS Room Air Temperature: \_\_\_\_\_ °F db \_\_\_\_\_ °F wb

Evaporator Coil Entering Air Temperature: \_\_\_\_\_ °F db \_\_\_\_\_ °F wb

Evaporator Coil Leaving Air Temperature: \_\_\_\_\_ °F db \_\_\_\_\_ °F wb

Evaporator Fan Motor -

Nameplate Data: Volts: \_\_\_\_\_ Phase: \_\_\_\_\_

Cycles: \_\_\_\_\_ Amps: \_\_\_\_\_

BHP: \_\_\_\_\_

Measured Current and Voltage (at motor terminals):

L1: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

L2: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

Measured Fan Speed: \_\_\_\_\_ RPM

Measured Supply Air Quantity: \_\_\_\_\_ CFM

Condenser Fan Motor:

Nameplate Data: Volts: \_\_\_\_\_ Phase: \_\_\_\_\_

Cycles: \_\_\_\_\_ Amps: \_\_\_\_\_

BHP: \_\_\_\_\_

Measured Current and Voltage (at motor terminals):

L1: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

L2: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

Refrigerant Type: \_\_\_\_\_

**Compressor -**

Suction Pressure: \_\_\_\_\_ psig

Discharge Pressure: \_\_\_\_\_ psig

High Pressure Cut-Out: \_\_\_\_\_ psig

Low Pressure Cut-Out: \_\_\_\_\_ psig

Nameplate Data: Volts: \_\_\_\_\_ Phase: \_\_\_\_\_ Cycles: \_\_\_\_\_

Amps: \_\_\_\_\_

Measured Current and Voltage (at compressor terminals):

L1: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

L2: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

Measured Current and Voltage (at heater terminals):

L1: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

L2: \_\_\_\_\_ Amps \_\_\_\_\_ Volts

**END OF SECTION**

**SECTION 15300**  
**PROPANE ENGINE GENERATOR SYSTEM**

**PART 1 - GENERAL**

- 1.1 **Work Included** - Contractor shall install all Government-Furnished Materials (GFM), including engine generator, exhaust muffler and other items as indicated on drawings. Contractor shall furnish and install piping as required to connect Government-Furnished engine generator to new fuel piping system and fuel storage tank. Contractor shall also furnish and install controls, electrical wiring, conduit, dampers and other related appurtenances as required to provide a complete and operable engine generator system. Installation shall be in accordance with all mechanical and electrical drawings and specifications.
- 1.2 **Manufacturer Certification** - All work shall be done by an experienced firm regularly engaged in the installation of that trade. Installation of tanks and piping shall be performed by an installer who has been certified or licensed in the installation of propane systems for a period of 5 years.

**PART 2 – PRODUCTS**

- 2.1 **Fuel Storage Tank** – The Contractor shall furnish and install an above ground propane fuel storage tank including all necessary piping and accessories. The tank shall be as shown on the drawings. Obtain all legal and regulation permits required for above ground tank installation.
- 2.2 **Piping** - All propane piping shall be UL Listed and NFPA approved. All materials shall be approved for use with propane by the state fire marshal. All joints shall be sealed airtight.
- 2.2.1 **Installation** - Arrange piping to provide a workable arrangement, with convenient access to valves and equipment. Maintain adequate clearance between runs of piping to permit access around adjacent pipe for dismantling, repair, and maintenance of valves and equipment. Piping shall be parallel to building surfaces, straight, plumb, and run direct as possible. Provide unions at all piping connections to equipment. Do not install piping over electrical equipment or interfere with equipment service space. Install piping by competent and skilled workmen.
- 2.3 **Pipe Supports** - All piping, except buried transfer piping, shall be supported from the building structure. Support of electrical conduit, equipment and other work from piping or pipe hangers will not be permitted. Likewise, support of piping from electrical conduit and other work will not be permitted.
- 2.3.1 **Installation** - All pipes shall be supported using pipe hanger or clamps designed for support of piping. Wire and strapping will not be permitted.
- 2.3.2 **Spacing** - Supports for pipes shall be spaced not more than 5 feet apart. Supports shall also be placed within 1 foot of each elbow and at all concentrated load points. Spacing requirements apply to both horizontal and vertical piping.
- 2.3.3 **Sizing** - Pipe hangers and clamps shall be sized to snugly fit finished surfaces of all insulated and un-insulated piping. Where piping is insulated, insulation protection shield shall encircle insulation at each pipe hanger and clamp. Protection shields shall be not less than 20 gauge galvanized steel, curved to snugly fit insulation surface, covering at least one-half of the circumference of the insulation and 12" in length.
- 2.4 **Propane Piping** - Contractor shall route propane piping inside engine generator room as shown on the drawings and as required to connect to new engine generator. All new piping shall be schedule 80 black steel with threaded ends, in accordance with ASTM A53 and NFPA.



- 2.4.1 Fittings and Unions** - Fittings shall be black, malleable iron in accordance with ANSI B16.3. Unions shall be black malleable iron, in accordance with ANSI B16.39.
- 2.4.2 Flexible Connections** - Flexible connections shall be in accordance with ANSI Z21.69.
- 2.4.3 Shut-Off Valves** - Shut-off valves shall be straightway, taper plug, regular pattern with a port opening at least equal to the internal pipe area or round port full bore pattern, non-lubricated, polytetrafluor-ethylene, (PTFE) packing, flat or square head stem with lever operator, 250 psig rating, threaded ends, in accordance with ANSI B16.33.
- 2.4.4 Pressure Regulating Valves** - Self-contained with spring-loaded diaphragm, psig inlet pressure and water outlet pressure reduction, pressure operating range as required for the pressure reduction indicated. Volume capacity not less than indicated and threaded ends for sizes 2 inches and smaller, otherwise flanged. Valves shall be as manufactured by Rego, Sherwood, or approved equivalent.
- 2.4.5 Solenoid Valves** - 2 position, direct-acting types, opened electrically as specified for use with propane gas. Valves shall be designed for 230 CFH with 4 psig inlet pressure and 11" W.C. (maximum outlet pressure). Valves shall be constructed so that they may be serviced without being removed from the line. Each valve shall include a coil housing, stem and plunger assembly non-magnetic to the plug, with stainless-steel enclosing tube, seat and plunger, and the proper inlet and outlet connections for installation into the piping system. The direction of flow shall be indicated on the valve body. The valve manufacturer shall be required to submit published ratings and maximum operating pressure differential. The coil housing shall include a moisture-proof coil in a metal housing with electrical wires extending through a female pipe tap conduit connection. Coils shall be wired for 120V-1P-60HZ electric service and be capable of withstanding the temperature of the liquid or gas encountered, plus the heat from the coil. Bodies, stems and pistons shall be of a material that will not corrode or pit when used in the propane system. Valves with threaded connections shall conform to American Standard NPT in accordance with ANSI B1.20.1. Shall be listed by Underwriters Laboratories and shall be as manufactured by ASCO.
- 2.5 Exhaust Piping and Muffler** - Furnish, install and support exhaust piping and muffler as shown and specified on drawings. Piping shall be 304L stainless steel, schedule 40.
- 2.6 Pipe Insulation** - Exhaust piping and muffler shall be insulated on all surfaces (with exception of exhaust piping located outdoors and flexible pipe connections) with asbestos-free calcium silicate, 1-1/2" thick molded pipe insulation finished with insulating cement and covered with smooth (non-corrugated) 0.016" thick aluminum alloy jacket.
- 2.7 Pipe Identification -**
- 2.7.1** All new piping shall have labeled identification not less than 8'-0" on centers to identify service and direction of flow. All identification locations and orientations shall require prior approval of Resident Engineer (RE).
- 2.7.2** Labeled identification shall meet ANSI specifications for color and letter size, shall be weather resistant, able to withstand temperatures up to 240 degrees F, and shall be manufactured by Seton Identification Products. Identification color band shall completely encircle piping (including pipe insulation where applicable) and shall utilize black letters with black flow arrows for the following piping:
- | <u>Service</u> | <u>Color band</u> |
|----------------|-------------------|
| Gas            | Yellow            |
- 2.7.3** Field painted or stenciled identification will not be permitted.

- 2.8 **Coolant** - In order to prevent damage to the engine immersion heater, Contractor shall fill the cooling (radiator) system before the set is connected to commercial power. Engine generator factory representative shall furnish coolant and shall supervise filling. Coolant shall include sufficient amount of ethylene glycol type anti-freeze to protect the engine against freezing down to -30°F, and an approved rust inhibitor.

### **PART 3 - EXECUTION**

- 3.1 **General** - Installation shall be in accordance with the manufacturer's current installation instructions, the contract drawings, and all applicable NFPA requirements. Perform all work in accordance with applicable statutes, ordinances and codes in force during time of construction period, and any regulations of governmental authorities having jurisdiction. Resolve any code violation discovered in contract documents with the Resident Engineer (RE) prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to the Government. Obtain and pay for all permits and inspections required by federal, state and local authorities.
- 3.2 **Wiring** - The Contractor shall provide all necessary power and control conductors, conduits, fittings, junction boxes and flexible connectors. All conduits and wiring shall be in accordance with the NFPA, NEC and electrical Divisions of this specification. All buried conduit and fittings shall be coated as specified in electrical Divisions. All exposed conduit and fittings shall be galvanized rigid steel conduit.
- 3.3 **Piping**
- 3.3.1 **Piping Installation** - Vent piping termination shall not be located within 10 feet of engine exhaust. Pipe connections shall be made with suitable thread compound after removing burrs. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Use whatever temporary connections are required for cleaning, purging and circulating.
- 3.3.2 **Piping Pressure Test** - Before pipe testing, all equipment including fuel storage tank, and engine generator shall be isolated from the new piping. Piping shall be capped at connection to equipment and existing piping system to facilitate testing. Piping shall be tested in the presence of the Resident Engineer (RE). Piping and connections shall be tested under fifty pounds of air pressure held for a minimum of two hours using a soap solution on all joints. Check for bubbling leaks. Use a pressure gauge marked in at least one-half pound increments to take readings.
- 3.4 **Fuel** - Contractor shall purchase all fuel necessary for testing and operation of engine generators included in this project. Contractor shall purchase additional fuel sufficient for 72 hours engine generator operation and shall make this fuel available upon demand. All fuel shall be propane.

**END OF SECTION**



**DIVISION 15400**  
**ABOVEGROUND PROPANE STORAGE TANK**

**PART 1 - GENERAL**

- 1.1 **Scope** - The Contractor shall furnish and install a steel, 1000 gallon, aboveground propane tank with a fuel monitoring system and all other related appurtenances. Obtain all legal and regulatory permits required for aboveground tank installation.
- 1.2 **Submittals** - Before any equipment is ordered or material fabricated, shop drawings must be submitted to and approved by the Resident Engineer (RE). In the interest of expediting approval and eliminating unnecessary confusion, it is recommended that all submittals required under this specification be made at one time and in one package.
- 1.2.1 **Manufacturer's Literature** - Provide product data, installation instructions, maintenance, operating and testing instructions for all Contractor furnished items.
- 1.2.2 **Shop Drawings** - Provide complete shop drawings showing the exact location of tank, leak monitoring system, tank gauging system, and related piping system.

**PART 2 - PRODUCTS**

- 2.1 **Piping** - All propane piping shall be UL listed and NFPA 30, 37, and 58 approved. All materials shall be approved for use with propane storage by the State Fire Marshall. All joints shall be sealed airtight.

**PART 3 - EXECUTION**

- 3.1 **Installation** - Installation shall be in accordance with the tank manufacturer's current installation instructions, the approved shop drawings and NFPA 30, 58 and 70. Perform all work in accordance with applicable statutes, ordinances and codes in force during time of construction period, and any regulations of governmental authorities having jurisdiction. Resolve any code violation discovered in contract documents with the Contracting Officer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner. Obtain and pay for all permits and inspections required by Federal, State and local authorities. Do not drill into the tank. Maintain a 25-foot clear area around the tank. Do not install the tank within 25 feet of any building equipment or property line.
- 3.2 **Wiring** - The Contractor shall provide all necessary power and leak sensing conductors, conduits, fittings, junction boxes, and flexible connectors and wiring shall be in accordance with the NFPA and NEC. All buried conduit and fittings shall be PVC coated. All exposed conduit and fittings shall be galvanized rigid steel conduit.
- 3.3 **Monitoring System Installation** - The monitoring system shall be installed in accordance with jurisdictional codes, NFPA and NEC. Furnish all components, conduit, and wires from the sensors and transmitter to the central control unit and remote alarm console. Underground conduits, junction boxes, fittings and couplings shall be watertight to prevent leakage of ground water into conduit. Furnish necessary power supply as indicated to control unit and remote console.



**3.4 Piping System Installation -**

**3.4.1 Cleaning** - Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Use whatever temporary connections are required for cleaning, purging, and circulating.

**3.4.2 Pressure Testing** - Before pipe testing, both the aboveground storage tank and engine generator shall be isolated from the piping. Piping shall be capped at both the tank connection and connection to associated system to facilitate testing. Piping shall be pressure tested in the presence of the RE. Piping and connections shall be tested under fifty pounds of air pressure held for a minimum of two hours using a soap solution on all joints. Check for bubbling leaks. Use a pressure gauge marked in at least one-half pound increments to take readings.

**3.5 Fuel** - Contractor shall fill tank to 90% capacity after all the necessary tests have been performed to the satisfaction of the RE. Take precautions required to prevent leakage or spillage of fuel during transfer, in accordance with applicable state laws and regulations.

**3.6 Quality Assurance**

**3.6.1 Manufacturer Certification** - All work shall be done by an experienced firm regularly engaged in the installation of that trade. Installation of tanks and piping shall be performed by an installer who has been certified or licensed in the installation of propane systems for a period of 5 years. Provide evidence of manufacturer training to install its' equipment and material. Manufacturer installation instructions shall be submitted to the FAA upon award of contract.

**3.6.2 Delivery, Storage and Handling** - Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the ground and protect from damage and exposure to elements. Remove damaged and deteriorated materials from the site.

**3.6.2.1 Government-Furnished Equipment Acceptance** - The Contractor, in the presence of the RE, shall inspect and receive the tank, monitoring system, and accessories.

**END OF SECTION**

**SECTION 15600**  
**VENTILATING SYSTEMS**

**PART 1 - GENERAL**

- 1.1    Work Included** - Modify existing ventilating systems for the engine generator equipment and room as described herein and indicated on the drawings. New ventilating system components include, but are not limited to, the following items:

- (1)      Exhaust fans
- (2)      Engine generator exhaust duct
- (3)      Intake/exhaust hoods
- (4)      Intake/exhaust dampers
- (5)      Air filters
- (6)      Automatic controls

**PART 2 - PRODUCTS**

**2.1    Sidewall Centrifugal Exhaust Fan**

- 2.1.1    Fan Construction** - Sidewall exhaust fan shall be outdoor wall mounted direct drive axial panel type. Construction of the windband shall be of heavy gauge aluminum with a rolled bead on the outer edge for strength. The fan wheel and inlet cone shall be aluminum. The fan wheel shall be of the aluminum, non-overloading, backward inclined type, statically and dynamically balanced. Blades, fins, inlet cones and back plates shall be securely fastened together into a rigid assembly.
- 2.1.2    Motor and Drives** – Motors shall be rigidly mounted on a heavy gauge wire basket/rear guard of concentric rings meeting OSHA specification. Vibration isolation shall be provided between the motor/guard assembly and a coated steel fan panel featuring welded corners, pre-punched mounting holes, and a deeply spun venturi. Statically and dynamically balanced propellers shall be die formed aluminum. Motors shall be continuous duty and permanently lubricated.
- 2.1.3    Certification** - Exhaust fan shall bear the AMCA Certified Ratings Seals for both air and sound performance.
- 2.1.4    Accessories** - Fan shall be complete with intake safety grille, disconnect switch, barometric backdraft damper and insect screen.

**2.2    Sheet Metal Work**

- 2.2.1    Requirements** - Furnish and install new sheet metal work as required to connect engine generator radiator discharge to wall exhaust hood and at all other locations as shown on the drawings and as required for proper operation of the ventilating system.
- 2.2.2    Omission of Details** - All details of the ductwork are not indicated on the plans and the necessary bends, offsets, elbows and transformations in ductwork are to be provided where necessary, whether or not shown on the plans.

- 2.2.3 Material and Gauges** - Ductwork shall be fabricated of the best grade galvanized steel. Gauges shall be as specified on the drawings. Where gauges are not specified, they shall be as recommended by SMACNA and ASHRAE.
- 2.3 Gravity Backdraft Dampers** - Gravity backdraft dampers shall be of the size shown on the drawings. Gravity backdraft dampers shall be the adjustable counterbalanced low leakage type, designed for operation in the vertical positions as shown. Blades shall be of .070-inch thick extended 6063-T5 aluminum with extruded silicone blade seals and polyurethane jamb seals. Frames shall be .081-inch thick, extruded 6063-T5 aluminum. Shafts are to be 1/2-inch diameter extruded aluminum with oiltite bronze bearings and face mounted linkage. Joints between aluminum and other metals shall be made with separators of polyvinyl tape or sheet neoprene. Fastenings shall be cadmium plated steel or equal. Dimensions of all openings shall be site verified. Backdraft dampers shall be Ruskin Model CBD4.
- 2.4 Flexible Duct Connection** - Contractor shall furnish and install a flexible duct connection at the engine generator radiator discharge as shown on drawings. Duct connections shall be air tight. Fabricate from fluoroelastomer (FRM) synthetic rubber capable of withstanding temperatures up to 400°F. Provide a minimum of 1/2 inch slack in the connections and a minimum distance of six inches between the edges of equipment and ductwork. Carefully align ductwork with equipment opening and securely fasten flexible connection to the engine generator and ductwork using draw bands.
- 2.5 Painting**
- 2.5.1 General** - Engine generator exhaust ductwork and intake/exhaust dampers shall not be painted. Exhaust fans and motors shall be factory primed and painted. Ductwork and dampers shall have factory applied galvanized finish. Intake/exhaust hoods shall be field painted as required to match color of adjacent building surfaces.
- 2.5.2 Finish** - Upon completion of work, all abrasions, scratches or other damage to factory or field painted surfaces shall be touched up as required for finish of all work to be equivalent to that of a new factory application. Lead based paint shall not be used in this project.

### **PART 3 - EXECUTION**

- 3.1 General** - Equipment shall be adjusted so that it will perform as specified and shown on the drawings.
- 3.1.1 Adjustments** - The temperature control system shall be adjusted and placed in operation by the Contractor. Readjustment necessary to accomplish the specified results during the first year of operation shall be made without cost to the Government.
- 3.1.2 Balancing** - All system components shall be adjusted and balanced as required to provide operation without objectionable noise, vibration or drafts.
- 3.1.3 Measurements** - Air quantities may be measured by pitot tube, anemometer or velometer, depending on the velocity and other conditions of flow.
- 3.1.4 Labor and Instruments** - All labor and instruments required for tests shall be furnished by the Contractor. If gauges, thermometers, etc., which are to be left permanently installed are used for tests, they shall not be installed until just prior to the tests to avoid possible changes in calibration.

**END OF SECTION**



**SECTION 16050**  
**BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.1 Work Included**

**A. General**

1. Furnish material, equipment, labor and incidentals necessary for complete and operational systems as specified herein.
2. This section concerns all other sections in Division 16 and shall be considered a part of each of those sections as if written in their entirety.
3. The general electrical requirements in this section are applicable to both GFE and non-GFE equipment.
4. Order of Precedence: Materials and equipment shall comply with all requirements of the contract documents. Materials furnished by the contractor shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with the specification requirements. If electrical material and equipment requirements conflict, the order of precedence for selection shall be as follows: FAA Specifications and Standards, Contract Specifications, Contract Drawings. And then in continuing order of precedence, Military Specification Federal Specifications, NFPA-70 "National Electrical Code", IEEE Standards, UL Standards and NEMA Standards. Wherever standards have been established by Underwriters' Laboratories, Inc., the material shall bear the UL label.
5. Replacement and spare parts shall be provided as indicated in other sections of Division 16.

**B. Provide the following electrical equipment and systems:** Equipment, wiring devices, and electrical connections required for installation of electrical equipment.

1. Service entrance equipment
2. Raceways and wiring for power and control, including underground ductbanks
3. Grounding systems
4. Cutting and patching for electrical construction

**C. Minor Departures:** Minor departures from exact dimensions shown in electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The Contractor shall promptly obtain approval from the FAA prior to undertaking any such departures, and shall provide appropriate documentation of the departure.

**1.2 Reference Standards**

- A. General:** Comply with the standards in effect as of the date of the Contract Documents as applicable to the extent specified in this Division. The rules, regulations and reference specifications enumerated in these specifications shall be considered as minimum requirements. Adherence to other standards shall not relieve the contractor from furnishing and installing higher grades of materials and workmanship when so required by this specification. Adherence to this specification shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship when so required by the Contract Drawings or special contracts provisions. Electrical work shall be executed in accordance with local, state, and national codes, ordinances, and regulations that have jurisdiction authority over the work. If Conflicts occur between FAA documents and any other document, the FAA requirements shall be used.

- B. **American Standard for Testing and Materials (ASTM)**
  - 1. D1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
- C. **Federal Aviation Administration (FAA)**
  - 1. STD-019e Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment
  - 2. STD-020b Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment
  - 3. C-1217f Electrical Work, Interior
  - 4. FAA-C-1391b Installation and Splicing of Underground Cables
- D. **Institute of Electrical and Electronic Engineers (IEEE)**
  - 1. 519 Recommended Practices and Requirements for Harmonic Control and Electrical Power Systems
- E. **National Electrical Manufacturers Association (NEMA)**
  - 1. WC70-00 Non-Shielded Power Cable 2000V or Less
  - 2. WC26-00 Binational Wire and Cable Packaging Standard
- F. **National Fire Protection Association (NFPA)**
  - 1. 70 National Electrical Code (NEC), latest edition
- G. **National Electrical Contractors Association (NECA)**
  - 1. 1-2000 Standard of Installation
- H. **Occupational Safety and Health Administration (OSHA)**
  - 1. 29CFR1907 Description and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
- I. **Underwriters Laboratories (UL)**
  - 1. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
- J. **National Electrical Safety Code (NESC)**
- K. **American National Standards Institute (ANSI)**
- L. **Uniform Building Code (UBC)**
- M. **Rural Electrification Association (REA)**
- N. **Insulated Power Cable Engineers Association (IPCEA)**
- O. **Association Edison Illuminating Companies (AEIC)**
- P. **Local Utility Companies**
- Q. **Federal Specifications:**
  - 1. J-C-30 Cable and Wire, Electrical (Power, Fixed Installation)
  - 2. L-T-1512 Tape, Wrapping, Pressure-Sensitive; Adhesive Tape 1512
  - 3. L-P-390 Plastic Molding and Extrusion Material, Polyethylene and Co-polymers Low, Medium Density
  - 4. W-C-582 Conduit, Raceway, Metal and Fittings: Surface



5. W-C-586 Conduit Outlets, Boxes, Bodies, and Entrance Caps, Electrical; Cast Metal – For Shore Use
6. W-F-406 Fittings for Cable, Power, Electrical and Conduit, Metal Flexible
7. W-F-408 Fittings for Conduit, Metal, Rigid (Thick-Wall and Thin Wall (EMT-Type)
8. W-S-610 Splice, Conductor
9. HH-I-510 Insulation Tape, Electrical, Friction
10. HH-I-595 Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic, or Low Temperature Application
11. W-C-563 Conduit, Metal, Rigid; and Bends and Elbows, Electrical Conduit: Thin Walled Type (EMT)
12. W-C-566 Conduit, Metal, Flexible
13. W-C-581 Conduit, Metal, Rigid and Intermediate; Coupling, Elbow, Nipple, Electrical Conduit: Zinc-Coated

### 1.3 **Job Conditions**

- A. Obtain and pay for all permits, licenses, and inspection completion as required by law for the completion of the work. Certificates of approval shall be secured, paid for and delivered to the Contractor before receiving the acceptance of the work.
- B. The location of materials, equipment, devices, and appliances indicated are approximate and subject to revisions at the time of installation. The Contract Drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.
- C. Should project conditions require any rearrangement of work, or if equipment or accessories can be installed to a better advantage than the general arrangement of work on the plans, the Contractor may, before proceeding with the work, prepare and submit plans of the proposed rearrangement to the Work Release Project Engineer (WRPE) designee.
- D. **Equipment Size:** Electrical equipment size indicated on the Contract Drawings is based on a particular manufacturer. It is the responsibility of the Contractor to verify that the equipment he proposes to furnish will fit in the space indicated on the Drawings.
- E. **Equipment Coordination:** Equipment furnished and installed under other Sections of this Specification and by the Contractor shall be coordinated with equipment furnished and installed under this section.
- F. Electrical work shall be performed under the supervision of a master Electrician who holds a valid license.
- G. **Code Violations:** Perform work to meet or exceed the requirements of the National Electrical Code and other applicable statutes, ordinances, codes, and regulations of the governmental authorities having jurisdiction. Resolve any code violations discovered in the Contract Documents with the Contracting Officer prior to award of the Contract.
  1. After the award of the Contract, make any corrections or additions necessary for the compliance with applicable codes at no additional cost to the Contractor.

### 1.4 **Guarantees**

- A. The work shall be guaranteed for one year from the date of final acceptance of the project and during that period the Contractor shall make repair at his expense any faults or imperfections that may arise due to defects of omissions in materials or workmanship.



**1.5 Work in Related Sections**

02200	Earthwork
02220	Installation of Underground Power Cable Systems
02324	Trenching
03301	Cast-in-place concrete

**1.6 Submittals**

- A. Component catalog numbers and manufacturer's data sheets, including pertinent data identifying each component by the item number and nomenclature, as specified.
- B. Within 5 days after the Notice of Award (NOA) of the contract and before orders are placed or shop drawings are submitted, the Contractor shall submit to the FAA a list of equipment and principal materials specified. Give names and manufacturer's catalog and model numbers and other such supplemental information as necessary for identification.
- C. **Project Record Documents:** Maintain at the job site a separate set of redline bond prints of the Contract Documents (specifications, drawings, change orders, addendums) for the purpose of recording the system and dimension changes of those portions of work in which actual construction is significantly at variance with the Contract Documents. The Contractor shall record changes for both GFE and Contractor provided equipment. Upon acceptance of the project, submit documents to the FAA, with verification of data accuracy. Mark the Record Drawings with colored pencil. Prepare the Record Drawings as the work progresses. Upon completion of work, submit Record Drawings clearly indicating the following:
  - 1. Locations of devices, conduits, equipment and other pertinent items; Indicate the depth of buried ducts and direct burial cables.
  - 2. Schematic and interconnection wiring diagrams of the completed power and control system incorporating the data derived from the equipment shop drawings, and the cable and conduit schedule. The drawings shall be detailed to wire and terminal block numbers, conductor color coding, device designations, locations, and reflect identifications established at the site.
- D. **Samples:** When the adequacy, quality, and safety of a material will be better demonstrated and it will expedite approval, provide single samples of items proposed for use. Conform to the procedures specified.
- E. **Test Report:** Submit a summary of the Electrical Test Report and Motor Test Report, noting deviations from requirements listed below:
  - 1. Maximum plus or minus five percent variation between nominal system voltage and no load voltage;
  - 2. Maximum plus or minus ten percent variation between average phase current and measured individual phase currents for panelboards.

**1.7 Quality Control**

- A. **General:** The rules, regulations and reference specifications enumerated herein shall be considered as minimum requirements and shall not relieve the Contractor from furnishing and installing higher grades of material and workmanship than are specified herein or when so required by the Contract Drawings. Materials, appliances, and equipment provided shall meet the requirements of the Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories (ETL) and other standard organizations. This specification shall govern when conflicts occur between reference documents and this specification.

- B. **Electrical Contractor's Qualification:** Use adequate numbers of skilled workmen, trained and experienced in their crafts, and who are familiar with the specifications and methods of performing the work in this Division.
  - C. **Licensed:** The electrical foreman shall be a licensed electrician.
  - D. **Workmanship:** Work shall be performed in accordance with quality, commercial practices. The appearance of finished work shall be of equal importance with its operation. Material and equipment shall be installed based upon the actual dimensions and conditions at the project site. Locations for materials or equipment requiring exact fit shall be field measured. Conduit, transformers, and motors shall be isolated to avoid unacceptable noise levels from objectionable vibrations from all systems.
  - E. **Contract Drawings:** Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the function to be performed even though some minor details are not shown, the Contractor shall furnish all equipment, material (other than Government furnished items), and labor to complete the installation work and accomplish all indicated functions of the electrical installation. Further, the Contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with all other disciplines, general, NFPA 70 latest edition, and FAA Standards.
  - F. **View Other Sections:** The Contractor is to review other sections of this specification to determine electrical requirements for equipment furnished under those sections. Coordinate all electrical rough-ins and connections for proper function of this equipment.
  - G. **Minor Departures:** Minor departures from exact dimensions shown in the electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The Contractor shall promptly obtain approval from the FAA prior to undertaking any such proposed departure.
  - H. **Listing and labeling:** Provide products specified in the section that are listed and labeled:
    - 1. The terms "Listed and Labeled" as defined in the National Electrical Code, (latest edition) Article 100.
    - 2. Listing and Labeling Agency Qualifications: NRTL as defined in OSHA Regulation 1910.7.
    - 3. Field installed nameplates shall conform to Division 16195, Electrical Identification.
    - 4. Nameplates on manufactured items shall be aluminum or type 304 stainless steel not less than 20 US Gauge, riveted, bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of the equipment data.
- 1.8 **Delivery, Storage, and Handling:** Follow the Manufacturer's directions for the delivery, storage, and handling of equipment and materials. Tightly cover equipment and materials and protect from dirt, water, chemical or mechanical injury and theft. Damaged equipment and material will not be acceptable. Upon installation, protect the materials until work is completed and accepted by the Contractor.
- 1.9 **Sequencing and Scheduling**
- A. Coordinate electrical equipment installation with other building components.
  - B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.
  - C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.



- D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work. Coordinate installing large equipment requiring positioning prior to closing in the building.
- E. Coordinate connecting electrical service to components furnished under other Sections.
- F. Coordinate connecting electrical systems with exterior underground and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

## **PART 2 - PRODUCTS**

### **2.1 Products**

- A. **Manufacturer's Recommendation:** While installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendation prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish the recommendations shall be cause of rejection of the equipment or material.
- B. Provide equipment and material of sizes, capacities, power ratings and dimensions as indicated on the Contract Drawings and in drawing schedules.
- C. All structural and miscellaneous steel used in connection with electrical work and located out-of-doors or in damp locations shall be hot dipped galvanized unless otherwise specified. Included are underground steel pull box covers and similar electrical items. Galvanizing shall average 2.0 ounce per square foot and shall conform to ASTM A123.
- D. Approval of materials and equipment will be based on the manufacturer's printed data. The label or listing of Underwriter's Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures of the Underwriter's Laboratories, Inc., and that the materials and equipment comply with all Contract requirements. A manufacturer's statement indicating complete compliance with the applicable Federal Specification or Standard of the American Society for Testing and Materials, National Electrical Manufacturers Association or other Commercial Standards, will be acceptable proof of such compliance.
- E. **Manufacturer's Standard Products:** Use colors prescribed by ANSI A13.1, NFPA 70.
  - 1. Materials and equipment shall conform to respective publications and any other requirements specified below. The Contractor shall furnish all materials. Materials and equipment, to be acceptable, must comply with all contract requirements. Materials to be furnished by the Contractor under this specification shall be of manufacturer's regularly engaged in the production of such material and of the manufacturer's latest designs that comply with the specification requirements.

### **2.2 Concrete Equipment Bases**

- A. **Forms and Reinforcing Materials:** As specified in 03301 "Cast-In-Place Concrete" Section of this Specification.



- B. **Concrete:** 3000 psi, 28-day compressive strength as specified in 03301 "Cast-In-Place Concrete" Section of this Specification.
- 2.3 **Electrical Identification:** Provide electrical Identification as specified in Section 16195, "Electrical Identification."
- 2.4 **Support for Electrical Equipment:** Channel and Angle Supports, Raceway Supports, Sleeves and Fasteners: As specified in Section 16190, "Supporting Devices."

### **PART 3 - EXECUTION**

#### **3.1 Equipment Installation Requirements**

- A. All materials and equipment shall be installed in accordance with the Contract Drawings, and with FAA-C-1217f, FAA-STD-019e, and FAA-STD-020b.
- B. **Coordinate electrical work with that of other trades so that:**
1. Interference between electrical and other specialty trades is to be avoided.
  2. Maintain clearances and advise other trades of clearance requirements for operation, repair, removal and testing of electrical equipment.
  3. All electrical materials and equipment shall be kept as close as possible to ceilings, walls and columns to occupy the minimum amount of space.
  4. Furnish and install all offsets, fittings and similar items necessary to accomplish the requirements of coordination without additional expense.
  5. Equipment required to be temporarily disconnected and relocated shall be carefully removed, stored, leaned, reinstalled, reconnected, and made operational.
- C. Where manufacturers recommended installation methods conflict with contract requirements, difference shall be resolved by the WRPE Designee.
- D. The installation shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulation, the workers shall be properly licensed.
- E. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
- F. Install items level, plumb, parallel, and/or perpendicular to other building systems and components, except where otherwise indicated.
- G. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- H. Maintain the waterproof integrity of conduit penetrations through the roof, exterior walls, and floors.
- I. The drawings indicate certain information pertaining to surface and subsurface obstructions that has been taken from available site drawings. Such information is not guaranteed as to accuracy of location or completeness. Coordinate trenching operations in accordance with Section 02325 "Trenching, Excavating, Compacting for Underground Utilities."
- J. Equipment shall be properly anchored and supported to resist shear and overturning moments for UBC Seismic Zone 2B.

- 3.2 **Excavation:** For excavation for installation of electrical utilities (power and control), refer to Sections 02200 Earthwork, 02220 Installation of Underground Cable Systems, and 02324 Trenching.

**3.3 Installation**

- A. **Contract Drawings:** Where the Contract Drawings schematically indicate the work, diagrammatically or electrically, ensure that the electrical and communications work is coordinated and compatible with Architectural, Mechanical and Structural work.
- B. **Support and Fastening:** Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with section 16190, "Supporting Devices."
- C. Install concrete pads and bases for electrical equipment in accordance with Section 03301, "Cast-In-Place Concrete."
- D. Install identification devices where required in accordance with the requirements of Section 16195, "Electrical Identification."
- E. **Wiring Methods:**
1. **General:** All wiring shall consist of insulated copper conductors installed in metallic raceways unless otherwise specified.
  2. **Conductor routing:** Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.
  3. **Conductor separation:** Power conductors shall be routed separately from all other conductor types. Route power conductors and other conductors in separate raceways, or by metallic divider between the power conductors and any other conductors in the same raceway, in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures
    - a. Power cables of less than 600 volts may be installed in the same duct.
    - b. Power cables of less than 600 Volts shall not be installed in the same duct with control, telephone, or signal type cables.
  4. **Neutral conductor:** Shared/common neutrals shall not be permitted, i.e., each overcurrent protection device shall have its own separate neutral conductor. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.
- F. All conduit openings through floors shall be both airtight and watertight.
- G. Seal equipment or components exposed to the weather and make watertight and rodent proof. Protect equipment outlet and conduit openings with temporary plugs or caps at all times work is not in progress.

**3.4 Cutting and Patching**

- A. Cut, channel, chase, and drill floors, walls, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.
- B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

**3.5 Testing**

- A. **General:** Unless otherwise indicated, the contractor shall furnish all test instruments; materials and labor necessary to perform tests designated Sections of this Division.



- B. **Calibration:** All tests shall be performed in the presence of the WRPE Designee. All instruments shall have been calibrated within a period of two years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.
- C. **Tests:**
1. An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service.
  2. After mechanical systems have been completely installed and balanced, test each system for proper operation.
  3. Tests shall be conducted in the presence of the FAA under design conditions to ensure proper sequence and operation throughout the range of operation.
  4. Make adjustments as required to ensure proper functioning of the systems.
  5. Special tests on individual systems are specified under individual sections.
  6. Provide 5 days written notice to the FAA for major tests. Contractor shall demonstrate, to the WRPE Designee's satisfaction, proper operation of control devices by simulating actual operating conditions.
  7. Devices tested shall include, but not be limited to, flow and pressure controls, temperature controls, and system interlocks and alarms.
  8. Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system.
  9. Repair or replace equipment that does not meet test requirements and retest. Notify the FAA in writing 5 days prior to conducting tests.
- D. **Instructions:** After final tests and adjustments have been completed, fully instruct the FAA and other personnel as directed by the FAA in details of operation and maintenance of electrical equipment.
- E. For grounding tests, refer to Section 16060 "Grounding and Bonding."
- F. For load balancing tests, refer to Section 16470 "Panelboards and Overcurrent Protective Devices."
- G. For conductor tests, refer to Section 16120 "Wire and Cables."
- H. **Underground Cable Test:** Test in accordance with FAA-C-1391b. Testing of GFM cable shall be performed before and after installation.

### 3.6 **Delivery, Storage and Handling**

- A. Clean and wipe the interior of conduit, pullboxes and panelboards before proceeding with the wiring.
- B. Do not install damaged, broken or marred material or products, replace them with new.
- C. On long-lead delivery items, which are damaged in shipping or storage, field repair may be authorized instead of replacement. Repair authorization must be in writing.

### 3.7 **Field Quality Control**

- A. **Restoration of Finish:** All marred or damaged surfaces, except exposed metal for grounding purposes, shall be refinished to leave a smooth, uniform finish at final inspection. Paint to match existing.



- B. **Repair of Existing Work:** Where cutting, channeling, or drilling of floors, walls, or other surfaces is necessary for the proper installation, support or anchorage of the conduit, raceways, or other electrical work, it shall be carefully done. The contractor shall repair with equal material by skilled workers, any damage to facilities caused by the contractor's workers or equipment. Prior FAA approval must be obtained for the materials, workers, time of day or night, repair method and for temporary or permanent repair purposes.
1. On completion, repair work shall be inspected and accepted by the FAA with the concurrence of any other affected parties such as Utility Companies and Airport Authority.
- C. **Damage:** Where conduit and wiring to remain are inadvertently damaged or disturbed, cut out and remove portion and all damaged wiring from the source panelboard, disconnect switch or pull box to the load/destination point. Provide new wiring of equal capacity.

**END OF SECTION**

**SECTION 16060**  
**GROUNDING AND BONDING**

**PART 1 - GENERAL**

- 1.1 **Summary:** This Section includes furnishing material, equipment and labor necessary to install a complete grounding system for the protection of life and equipment from lightning and power faults, and for minimizing electromagnetic interface. Grounding requirements specified in this Section may be supplemented by requirements in other Sections of these Specifications. Work shall include the following systems:

1. Power System Grounding
2. Electrical and Electronic Equipment Grounding
3. Raceway Grounding and Bonding
4. Multipoint Grounding

- 1.2 **Reference Standards:** Applicable only to the extent specified.

**A. American National Standards Institute (ANSI)**

1. C62.41 Recommended Practices on Surge Voltages in Low-Voltage AC Power Circuits

**B. American Society for Testing and Materials (ASTM)**

1. B3 Soft or Annealed Copper Wire
2. B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft
3. B33 Tinned Soft or Annealed Copper Wire for Electrical Purposes.

**C. Federal Aviation Administration (FAA)**

1. C-1217f Electrical Work, Interior
2. STD-012 Paint Systems for Equipment
3. STD-019e Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment
4. STD-020b Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment
5. Order 6950.20 Fundamental Considerations of Lightning Protection, Grounding, Bonding, and Shielding

**D. Institute of Electrical and Electronic Engineers (IEEE)**

1. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
2. 1100 Powering and grounding sensitive electronic equipment

**E. National Fire Protection Association (NFPA)**

1. 70 National Electrical Code (NEC), latest edition
2. 77 Static Electricity
3. 780 Lightning Protection Code

**F. Occupational Safety and Health Administration (OSHA)**

1. 29CFR1910.7 Definitions and Requirements for Nationally Recognized Testing Laboratories (NRTL)

**G. Underwriters Laboratories (UL)**

1. 96 Lightning Protection Components
2. 96A Installation Requirements for Lightning Protection Systems
3. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
4. 467 Grounding and Bonding Equipment

**1.3 Submittals**

- A. Product Data for grounding rods, connectors and connection materials, and grounding fittings.
- B. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.
- D. Surge and Transient Protection Requirements.

**1.4 Quality Control**

- A. **Testing Agency Qualifications:** A NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.
  - 1. **Testing Agency Field Supervision:** Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Comply with FAA specification C-1217f, FAA-STD-019e, FAA-STD-020b, and FAA Order No. 6950.20.
- C. Comply with NFPA 70, National Electrical Code, latest edition.
- D. Comply with UL 467.
- E. **Listing and Labeling:** Provide products specified in this Section that are listed and labeled.
  - 1. **The terms "Listed" and "Labeled":** As defined in the National Electrical Code, Article 100.
  - 2. **Listing and labeling Agency Qualifications:** A NRTL as defined in OSHA Regulation 1910.7.

**PART 2 - PRODUCTS**

- 2.1 Grounding and Bonding Products:** Of types indicated and of sizes and ratings to comply with FAA C-1217f, FAA-STD-019e, FAA-STD-020, and FAA Order No. 6950.20. Where types, sizes, ratings and quantities indicated are in excess of requirements above, the more stringent requirements and the greater size, rating, and quantity indications shall govern.

**2.2 Earth Electrode System (counterpoise)**

- A. **Grounding Electrode Conductor:** The grounding electrode conductor shall be bare or insulated (not green) copper and shall be sized and indicated as shown on the contract documents.
- B. **Ground Rods:** Ground Rods shall be 3/4 inch diameter by 10 feet copper or copper-clad steel. Sectionalized type or exothermic butt welded rods shall be provided when deeper earth penetration is required. Ground rods shall bear the manufacturer's name, trademark and catalog number.
- C. **Access Wells:** Access wells shall be pre-cast concrete, and have a removable cover. The access well shall have a minimum interior measurement of 24 inches circular clearance, and be of sufficient size to allow ground rod connections to be readily accessible for testing and maintenance. All connections shall be made by the exothermic weld process.



### 2.3 Wire and Cable Grounding Conductors

- A. **Comply with Section 16120 "Wires and Cables":** Conform to NEC Table 8 "Conductor Properties," except as otherwise indicated on Contract Drawings.
1. **Material:** Use only copper wire for both insulated and bare for grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials. Conductors shall conform to the following:
    - a. **Solid Conductors:** ASTM B3
    - b. **Assembly of Stranded Conductors:** ASTM B8
    - c. **Tinned Conductors:** ASTM B33
  2. **Size:** Bare ground conductors shall be sized in accordance with NEC and FAA STD 019e. Minimum allowable size of ground conductors in contact with earth shall be not less than #2 AWG.
- B. **Equipment Grounding Conductors:**
1. Copper conductor with green color insulation.
  2. **Size:** Equipment grounding conductors shall be sized the same as phase conductors per FAA-STD-019e.
- C. **Underground Conductors:** Bare, tinned, stranded, except as otherwise indicated.

### 2.4 Miscellaneous Conductors

- A. **Raceway Bonding Jumpers:** Copper, minimum size #6 AWG above grade, #2 AWG below grade.
- B. **Guard Cable:** #1/0 AWG, 7 strand, bare copper cable.
- C. **Counterpoise Cable:** Minimum #4/0 AWG, 7 strand, bare copper cable.

### 2.5 Connector Products

**Exothermic Welded Connections:** Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items. All underground conductor-to-conductor connections and conductor to ground rod connections shall be made by the exothermic weld process, unless otherwise noted. For certain materials and shapes which exothermic welds may not be possible, coordinate connection method with Work Release Project Engineer (WRPE) Designee.

1. **Substitutes:** Provide exothermic connections equal to Cadweld. To substitute another exothermic weld process, the Contractor must submit a chemical analysis by an independent test laboratory certifying:
  - a. The material used contains no phosphorous, caustic, toxic or explosive substance.
  - b. Weld material used for ground connections contains copper oxide, aluminum and not less than 3% tin as a wetting agent. Weld metal for cathodic connections shall contain vanadium, but no tin.
  - c. A minimum of 80 percent of the weld metal shall screen out between 30 and 140 Mesh.
  - d. Exothermic Weld shall meet the applicable requirements of IEEE-80, Chapter 9, Section of Conductors and Joints.
  - e. Molds shall be made from graphite or other material withstanding welding temperatures and shall be designed to provide average life of not less than 50 exothermic welds under normal conditions. The molds shall bear permanent marking, indicating the name of the manufacturer., the mold model, the type, and size of the welding mixture compatible with the welding process and the size of the conductor. Instructions detailing general safety information, welding procedures shall be provided with each mold. The installer is prohibited from using a mold from one manufacturer with a different manufacturer's welding mixture.

2. Application: Exothermic connections to be used outdoors shall be suitable for exposure to the elements and direct burial without degradation over the grounding system.

### **PART 3 - EXECUTION**

#### **3.1 Application**

##### **Grounding:**

1. Installation of FAA grounding requirements often exceed those of NEC; therefore, grounding system shall be installed as indicated in Contract Drawings, and as specified herein. Reference IEEE-1100-1992, "Recommended Practice for Powering and Grounding Sensitive Electronic Equipment", when installing equipment. In no case shall the NEC be violated.
2. Under no circumstances shall the equipment grounding conductor be omitted from the electrical system, nor shall any separate grounding system such as electrical signal ground or direct connections to the Earth Electrode System be used for an alternate grounding system or an alternate path to the grounding electrode conductor.
3. All ground connections to equipment shall be made with a ground connector specifically intended for that purpose.
4. Equipment grounding conductor shall be connected to the grounded conductor (neutral) only at the service disconnecting means and at separately derived systems. This connection is sometimes called the "Main Bonding Jumper."

#### **3.2 Installation:**

- A. Install grounding systems in accordance with FAA C-1217f, FAA STD-019e, FAA STD-020b and local codes.
- B. **Service Entrance Grounding:** At the service entrance equipment, bond the service neutral, building neutral and building ground conductor to a common ground bus (or lug). Connect the ground bus (or lug) to the counterpoise grounding system with the grounding electrode conductor. All connections at the service shall be made on ground buses (or lugs). Split bolts or cable clamps are not allowed to for this connection.
- C. **Grounding Electrode Conductor:** This conductor shall be connected to the neutral bus in the service disconnecting means and shall extend directly to a ground rod in the grounding electrode system in one continuous unspliced run. The ground electrode conductor shall be insulated with black insulation and sized as shown in the Contract Drawings. When not indicated in the contract documents, the conductor shall be sized in accordance with NEC Table 250-66 "Grounding Electrode Conductor for AC Systems," except that the conductor shall not be smaller than #2 AWG per FAA STD 019e. All grounding electrode conductors, except for those at the outdoor utility transformers, shall be routed in PVC conduit. Where the grounding electrode conductor is routed through a metal conduit or raceway, the raceway shall be electrically continuous and bonded to the conductor at each end with a solid copper conductor welded to the conduit. The grounding electrode conductor shall be connected to the Earth Electrode System by exothermic means. Make connections readily accessible for inspection. For a separately derived system such as an isolation transformer, the ground electrode conductor shall be connected in accordance with the NEC..



- D. **Grounded Conductor (Neutral):** Shared/common neutrals (grounded conductor) shall not be permitted, i.e., each overcurrent protection device shall have its separate grounded conductor. Grounded conductors shall be sized in accordance with NEC Article 250.
- E. **Earth Electrode System (Counterpoise):** Unless otherwise indicated on Contract Drawings, the grounding electrode system shall consist of a minimum of four (4) ground rods located at each corner of the structure.
1. Ground rods shall be interconnected by a buried, bare, #4/0 AWG, 7 stranded copper cable. The ground cable shall be directly buried at least 2'-6" below grade level. The interconnecting cable shall close on itself, forming a complete loop, with the ends exothermically welded. Provide sufficient mechanical protection during installation so as not to break cable or connections.
  2. Connect structural steel of buildings the earth electrode system with a bare, #4/0 AWG cable.
  3. All underground metallic pipes, metallic conduit, tanks, and telephone ground shall be connected to the earth electrode system by a copper cable no smaller than #2 AWG. Exothermic welds shall not be used where hazards exist, i.e. near fuel tanks. In these cases, pressure connectors will be allowed as approved by WRPE Designee.
  4. All exposed non-current carrying metallic parts of electrical and mechanical equipment including metallic raceway systems, piping, steel columns and structural members and neutral conductors of the wiring systems shall be grounded as required by the NEC and FAA STD 019e.
  5. Install ground cables in conduit where routed above grade, unless otherwise indicated on Contract Drawings.
  6. **Guard Wire:** Install guard wire in trench lines where protecting PVC or direct buried cables. Connect guard wire to ground rods and the earth electrode system by exothermic means. . Space ground rods 90 feet nominal in trenchlines. Locate ground rods 2 feet outside of trench/handhole wall.
  7. Ground pad-mounted equipment and non-current-carrying metal items by connecting them to Earth Electrode System by exothermic means.
  8. **Ground Rods:** Install ground rods as follows:
    - a. **Spacing:** Ground rods shall be as widely spaced as practical, and shall not be spaced less than one rod length apart. Spacing between rods around structures should be between 10 to 30 feet, nominal 20 feet, as shown on Contract Drawings.
    - b. **Depth of rods:** Tops of vertically-driven ground rods shall be not less than 12 inches below grade level.
    - c. **Location:** Ground rods shall be located 2 to 6 feet outside the foundation or exterior footing of the structure.
    - d. **Manholes and Handholes:** Install driven ground rods 2 feet from outside wall of handhole/manhole. Install a #2 AWG bare conductor from ground rod in manhole/handhole through a waterproof sleeve in manhole/handhole wall, and exothermically weld to the ground rod. Install a copper ground bus in each handhole/manhole.
  9. **Access Wells:** Install where indicated on contract drawings. Set top of well flush with finished grade or floor. Place gravel in well to a level 3 inches below ground rod connections.
- F. **Equipment Grounding Conductors:** All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings.
1. **Size:** Size equipment grounding conductors in accordance with Table 250-122 of the NEC, "Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment." Where ungrounded conductors are increased in size to compensate for voltage drop, the equipment grounding conductors shall be increased in size proportionately per the NEC. Minimum size shall be #12 AWG.
  2. Install equipment ground conductors in the same raceway as its related feeder and branch circuit conductors. Connect this conductor to the ground bus in the panelboard.
  3. Sharing of equipment ground conductors between circuits is not permitted. Each overcurrent



- protection device shall have its own separate equipment grounding conductor.
4. Metal conduit housing the equipment ground conductors shall be electrically continuous forming a parallel path to the equipment ground conductor.
  5. All connections to equipment to be grounded shall be made with a grounding connector specifically intended for that purpose.
  6. Bare wire wrapped around connecting screws or mounting bolts and screws, is not acceptable as a ground connection. All ground lugs shall be of a non-corrosive material suitable for use as a ground connection and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc.
  7. Conduit or cable shields shall not be used as the equipment ground conductor.

**H. Conduit:** All metal conduit shall be grounded as follows:

1. All joints between conduit sections and between conduit, fittings and boxes shall be electrically continuous. All pipe and lockout threads shall be treated with a conductive lubricant prior to assembly. Joints that are not otherwise electrically continuous shall be bonded with short jumpers of #12 AWG or larger copper wire. The jumpers shall be welded or brazed in place or shall be attached with clamps, split bolts, grounding bushings or other devices approved for the purpose. All bonds shall be protected against corrosion. Cover plates of conduit fittings, pull boxes, junction boxes and other outlet boxes shall be grounded by securely tightening all available screws.
2. Every component of metallic conduit runs such as individual sections, couplings, line fittings, pull boxes, junction boxes and outlet boxes shall be bonded, either directly or indirectly, to the ground system or facility steel. Conduit brackets and hangers shall be securely bonded to the conduit and to the metal structure to which they are attached.

**I. Equipment Enclosure Grounding:** Ground all enclosures (panels, boxes, cabinets, etc.) of electrical and electronic wiring distribution equipment with approved ground lugs in accordance with the NEC.

**N. Sleeves:** Where ground cables pass through slabs, buildings etc., and when not in metallic enclosures, provide a PVC conduit sleeve.

**P. Electronic Multipoint Ground System:** Insulated; color shall be green with bright orange tracer. Where cables are concealed and not color-coded, any exposed portion of the cable and each end of the cable for a minimum of 2 feet shall be color coded by green tape overlaid with bright orange tape to form the tracer. Where routed through raceways or wireways, the color-coding shall be such that by removing or opening any cover, color-coding shall be visible.

**R. Fault Protection:** Prevent equipment parts subject to human contact during installation from being electrically energized during powering faults or when components fail. Ground parts with a low impedance path to the chassis or cabinets in which they are mounted.

**3.3 Connections:**

- A. Materials procured and installed in this Section shall be in accordance with FAA C-1217f, FAA STD-019e, FAA STD-020b.
- B. Make connections so that the possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors and connection methods so metals in direct contact will be galvanically compatible.
  1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series:
    - a. Make connections with clean, bare metal at points of contact.
    - b. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- c. Where exothermic welding cannot be used or is inappropriate, use FAA approved "U" type bronze pipe connections.
- C. **Exothermic-Welded Connections:** Used for connections to structural steel and for underground connections. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- D. **Ground lugs and bushings:** Terminate insulated equipment grounding conductors for feeders with pressure-type ground lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a ground bushing. Connect ground bushings with a bare ground conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare ground conductors.
- E. **Other Grounding Systems:** Any additional ground systems used for electronic equipment shall be connected directly to the exterior earth electrode system. The conductor used for other ground systems shall be color coded as follows:
  - 1. Green with a bright orange stripe and for multipoint signal ground
- F. **Connections at Access Wells:** Use exothermic welded connections between conductors and grounding rods in access wells unless otherwise indicated on Contract Drawings.
- G. **Torque:** Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.
- H. **Compression-Type Connections:** Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector" or equipment when operated at a force of 24,000 pounds are acceptable as FAA approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in a lightning protection system.
- I. **Lug Type Connections to Equipment:** Use NEMA 2-hole ground lugs. Grounding lugs, connectors and other components shall comply with the NEC, latest edition.

#### 3.4 **Bonding Requirements**

- A. **Method:** At each location where conduits first penetrate a shelter or building's exterior wall direct connections shall be made to the equipment ground.
- B. **Location:** Bonding straps include jumpers, shall be installed in the following locations:
  - 1. Bonding straps shall be attached to the basic member.
  - 2. Bonding straps shall be installed to be unaffected electrically by motion or vibration.
  - 3. Bonding straps shall be installed whenever possible in areas accessible for maintenance.
  - 4. The method of installation and point of attachment of bonding straps shall not weaken the members to which they are connected.
- C. **Bonding Straps:** Bonding straps shall not be compression-fastened through non-metallic material.



### 3.5 Field Quality Control

- A. **Tests:** Perform tests described below. Ensure no connection to utility power is made during testing.
1. Fall of Potential: Subject the completed EES system to a earth resistance test using a ground test null balance megger instrument designed for the purpose, such as a Biddle, utilizing the fall of potential method (3-point). Refer to Section 16060-3.6. Measure ground resistance not less than 3 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - a. Earth Electrode System Resistance: The resistance of the earth electrode system shall not exceed 10 Ohms unless otherwise noted.
  2. Bolting Resistance: Spot test to verify that ground cable bolted connections have a DC resistance of one milliohm maximum, when measured with a bridge type milliohmeter or similar instrument.
  3. Continuity: Test ground conductors, sheet metal, metallic conduits, cellular metal deck, equipment enclosure, metallic enclosures, and lighting fixtures for continuity to ground system with a meggar.
  4. Bonding Resistance: Unless otherwise specified all bonds shall exhibit a resistance of one milliohm or less when measured between bonded members with a 4 terminal milliohm meter.
  5. Witness: Tests shall be witnessed by RE and Local FAA.
- B. **Deficiencies:** Where ground resistances exceed specified values, tighten connections, modify the EES system by the addition of additional ground rods, or replace faulty wiring as required until continuity/resistance conforms to the NEC requirements and the requirements of this Specification. Re-measure the continuity/resistance to verify compliance.
- C. **Report:** Prepare test reports, certified by the testing organization, of continuity/resistance at each test location. Include observations of weather and other phenomena that may affect test results. Submit test reports to RE.

- 3.6 **Earth Electrode System Resistance Test Procedure:** A qualified electrician furnished by the contractor, shall perform the following test. The following procedure is the fall of potential method (three terminal test). Connections of ground test equipment to probes and EES is shown in Figure 16060-1.



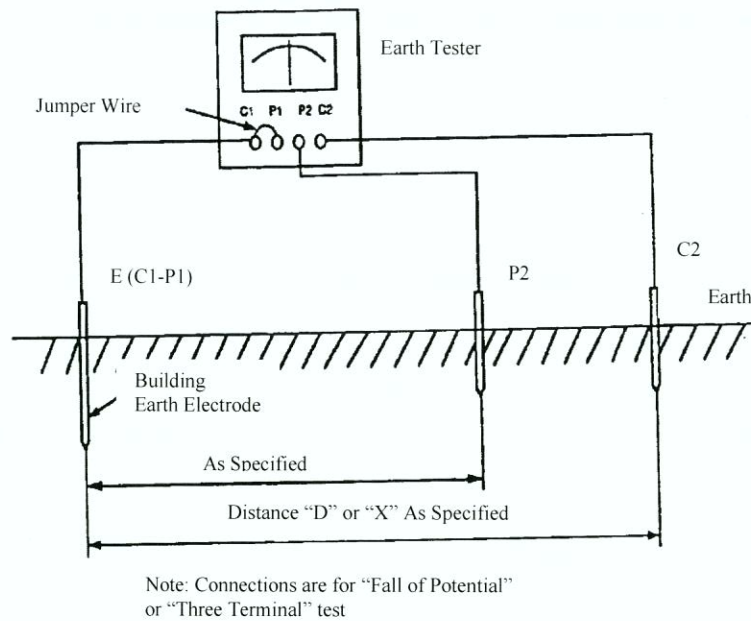


Figure 16060-1 Fall of Potential Test Connections

- A. **Sketch:** Prepare a sketch utilizing template sketch shown in Figure 16060-5 of the EES and the contract drawings. Select a point on the EES and a direction of measurement which is away from the EES under test, and away from known underground metallic objects (water pipes, cables, etc.).
- B. **Connection to EES:** Connect the jumpered C1-P1 lead to the EES at point E.
- C. **Position of current probe C2:** From the Selected electrode or point E and in the chosen direction, position the current probe (C2) at a convenient distance (D) or (X) from the measurement point. Refer to Test Method B and see samples shown in Figure 16060-3. (NOTE: Readings obtained for the facility ground resistance are more accurate when the spacing between E and probe C2 is maximized. The distance chosen may be limited to the area available. Vary probe spacing to avoid paved areas).
- D. **Position of Potential Probe P2:** Refer to test Method "B".
- E. **Measurements:** Drive Probes 4" to 12" Deep into Earth at several points on a straight line between the measurement point (E) and Probe (C2). Measure the resistance in accordance with the instrument manufacturer's instructions. When performing these measurements the resistance read should increase to a certain point, level off, and increase again. A plot of Resistance to Earth vs. Distance may be drawn by using the values obtained as the P2 probe is moved toward or away from the C2 probe. The correct resistance to earth at the electrode being measured at point (E) is estimated by extrapolating the curve to its asymptotic value (where curve levels off) as shown in Figure 16060-3. This test is repeated to verify correct readings. If the curve does not level off, the current probe (C2) must be placed at an increased distance from the measurement point (E).
  1. Repeat the above measurements in other directions at least 60 degrees from the first line of measurement and from other earth electrodes of the earth electrode system being checked. Whenever the test probe locations are moved to other areas, there may be a difference in soil

conditions which will result in a change to the resistance values at each probe position and/or the derived plot obtained.

F. **Test Method "B" (Perform for ALSF and VOR Facilities Only)**

1. Position the C2 probe along a line which maximizes the distance from the EES under test and from other buried metals such as utility pipes, power and signal cables, fuel tanks, etc. In choosing the direction for placement of the C2 probe, examine the configuration of the electrode system for the facility and determine the location of all such buried metal systems. Then locate the probe as far as possible from these metals as illustrated in Figure 16060-2. Keep C2 and P2 leads separated as far as possible.
2. Position the C2 and P2 probe at distances as shown in Figure 16060-2. Record the resistance readings at each probe position in Table shown in Figure 16060-4. (Note that the P2 positions are 62% of the C2 positions). It may not be necessary to plot the full 500 feet. Plot enough points to accurately determine where the curve levels off.
3. Plot on a graph (Figure 16060-4) as many recorded resistance readings versus the corresponding probe positions as necessary to determine where the curve levels off.
4. The true value of resistance can be estimated by extrapolating the curve to its asymptotic value (where curve levels off). Refer to sample data and graph in Figure 16060-3.

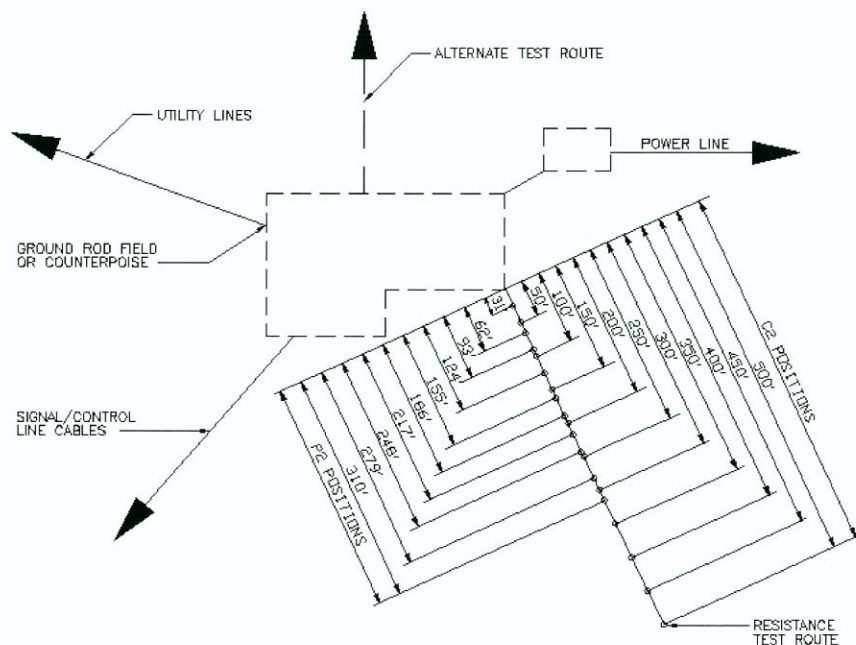
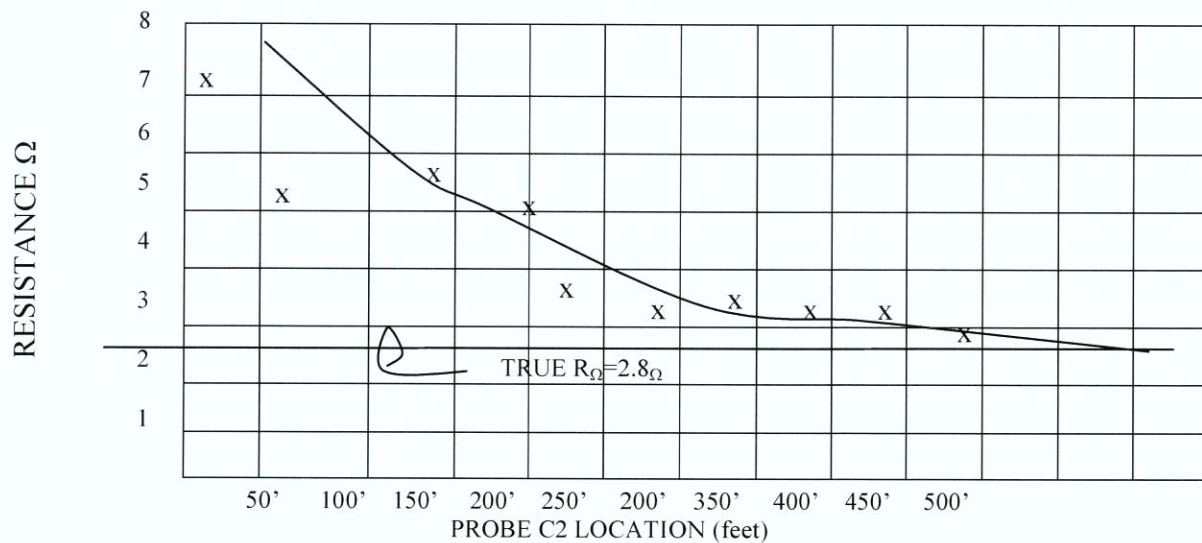


Figure 16060-2 Method B Test Route (Sample)



**EARTH RESISTANCE GRAPH (SAMPLE)**

C2 PROBE DISTANCE (Feet)	P2 PROBE DISTANCE (.62 x C2) (Feet)	RESISTANCE METER READING (Ω)
50	31	7.5
100	62	5.2
150	93	5.9
200	124	5.2
250	155	4.2
300	186	3.4
350	217	3.8
400	248	3.4
450	279	3.4
500	310	3.1

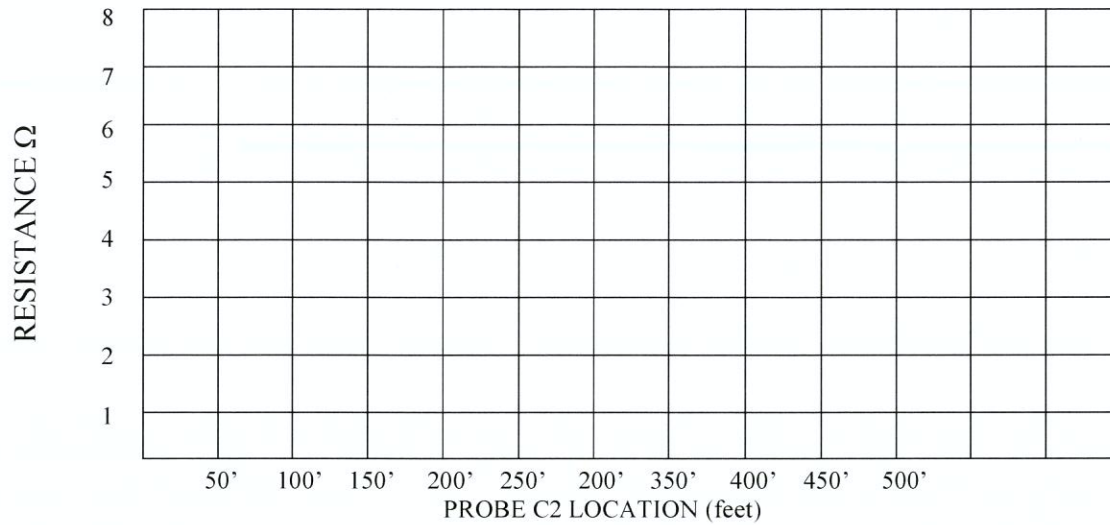
DEPTH OF REFERENCE PROBES= \_\_\_\_\_

$R_{\Omega}$  (REFERENCE RESISTANCE) = \_\_\_\_\_

**EARTH RESISTANCE DATA TABLE (SAMPLE)**

**FIGURE 16060-3 METHOD B DATA TABLE AND GRAPH (SAMPLE)**





**EARTH RESISTANCE GRAPH (BLANK)**

C2 PROBE DISTANCE (Feet)	P2 PROBE DISTANCE (.62 x C2) (Feet)	RESISTANCE METER READING ( $\Omega$ )
50		
100		
150		
200		
250		
300		
350		
400		
450		
500		

DEPTH OF REFERENCE PROBES= \_\_\_\_\_

$R_{\Omega}$  (REFERENCE RESISTANCE) = \_\_\_\_\_

**EARTH RESISTANCE DATA TABLE (BLANK)**

**FIGURE 16060-4 TEST METHOD B DATA TABLE AND GRAPH (BLANK)**

- 3.7 **Adjusting and Cleaning:** Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying and other activities to their original condition in accordance with other sections of this specification. Maintain restored surfaces.

**End of Section**

**SECTION 16119**  
**UNDERGROUND DUCTS AND UTILITY STRUCTURES**

- 1.1 **Summary:** This Section includes furnishing labor, materials, equipment, and incidentals necessary to install underground conduits and ducts, duct banks, pull cords, duct markers, capping of conduits, handholes, manholes, and other underground utility structures in accordance with dimensions, designs and details shown on the Contract Drawings.

1.2 **Reference Standards**

- A. **American National Standards Institute (ANSI)**
1. C2 National Electrical Safety Code
  2. C80.1 Rigid Steel Conduit, Zinc-Coated
- B. **Federal Aviation Administration (FAA)**
1. FAA-C-1391b Installation and Splicing of Underground Cables
- C. **American Society for Testing and Materials (ASTM)**
1. C270 Specification for Mortar for Unit Masonry
  2. C387 Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
  3. C857 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
  4. C858 Specification for Underground Precast Concrete Utility Structures
  5. C891 Specification for Installation of Underground Precast Concrete Utility Structures.
  6. C1037 Standard Practice for Inspection of Underground Precast Concrete Utility Structures
- D. **National Fire Protection Association (NFPA)**
1. 70 National Electrical Code (NEC), latest edition
- E. **Occupational Safety and Health Administration (OSHA)**
1. 29CFR Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

1.3 **Definitions**

- A. **Duct:** Electrical conduit and other raceway, metallic, used underground, embedded in earth or concrete.
- B. **Duct Bank:** 2 or more conduits or other raceway installed underground in the same trench or concrete envelope.
- C. **Handhole:** An underground junction or pull box interconnected with a duct or duct bank.

- 1.4 **Submittals:** Product data for metal accessories for handholes, conduit and duct, duct bank materials, trench marking tape and miscellaneous components.

- A. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.



- B. Inspection report for factory inspections, according to ASTM C 1037.
- C. Coordination drawings showing duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to accurate scale.
- D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their expertise, capabilities and experience.
- E. Field test reports indicating and interpreting test results relative to compliance with performance requirements of "Field Quality Control" Article in Part 3 of this Section.
- F. **Record Documents:** Show dimensioned locations of underground ducts and handholes.

**1.5 Quality Control**

- A. **Manufacturer Qualifications:** Firm experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a record of successful in-service performance.
- B. Comply with NFPA 70, NEC latest edition, and ANSI C2 for components and installation.
- C. **Listing and Labeling:** Provide products specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
  - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- D. Coordinate layout and installation of ducts and ductbank handholes with final arrangement of other utilities as determined in the field.
- E. Coordinate elevations of duct and duct bank entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to handholes, and as approved by the Work Release Project Engineer (WRPE) Designee.
- F. Install underground ductbanks and handholes in accordance with the requirements of the local power company and local telecommunications company, as appropriate.

**1.6 Delivery, Storage, and Handling**

- A. Deliver ducts to site with ends capped.
- B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

## **PART 2 - PRODUCTS**

### **2.1 Materials**

- A. **Materials:** All equipment and materials covered by this referenced specification shall be subject to acceptance through the manufacturer's certification of compliance with the applicable specification when so requested by the WRPE Designee.
- B. **Concrete:** Concrete for precast handholes shall be the manufacturer's standard mix for obtaining minimum compression strength of 3000psi or as shown on Contract Drawings. Concrete shall be air entrained. Concrete shall conform to the requirements of Section 03301 "Cast-in-Place Concrete."
1. **Mortar:** Conform to ASTM C270, Type M, except for quantities less than 2.0 cu. ft. (60 L), where packaged complying with ASTM C387, Type M may be used.
- C. **Handhole:** Provide pre-cast handholes as follows:
1. Dimensions shall be as noted on Contract Drawings.
  2. The number of conduit or terminators entering the handhole shall not be less than as detailed on the plans. Provide knockouts windows in unused sides of the handhole and sleeves for ground rod.
  3. Interlocking, mating sections, complete with accessory items, hardware, and features as indicated.
  4. **Joint Sealant:** Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.
  5. Design structure according to ASTM C858.
  6. Structural Design Loading: ASTM C857, Class A-16.
  7. Fabricate according to ASTM C858.
  8. Design loads shall consist of dead load, live load, impact load, loads due to water table and any other loads which may be imposed upon the structure. Live loads shall be for Aircraft or H20 loading as shown on Contract Drawings.
  9. Prepare and submit detailed shop drawings for pre-cast handholes indicating reinforcement, dimensions and details of each miscellaneous item. The handhole design shall be checked by a Registered Professional Engineer in the state where project is located. All handhole drawings shall bear Registered Professional Engineers Seal and signature.
    - a. All shop drawings shall be checked by the fabricator before being submitted for approval to the FAA.
    - b. The Contractor shall be responsible for the correctness and completeness of the drawings and fit and field connections even if the drawings have been approved by the FAA.
  10. All reinforcing steel, including welded wire mesh, shall be of the size and in the location as shown on the plans. All reinforcing shall be sufficiently secured to withstand any displacement during the pouring operation. Reinforcing steel shall conform to the requirements of Section 03301 "Cast-in-Place Concrete."
  11. Duct terminators:
    - a. Terminators shall be formed of high impact, high strength, prime virgin acrylonitrile butadiene styrene (ABS) plastic, containing the proper number, size, and arrangement of openings to receive ducts as shown on the plans, with 2-inch nominal separation between openings.
    - b. Terminators shall be hollow, to allow placement of reinforcing steel inside. Terminators shall provide for reception of future ducts and factory plastic plugs of proper size. Plugs shall be furnished and installed in all empty duct openings. Installation in handholes shall be in accordance with manufacturer's instructions.



12. Covers shall be bolt down type. Covers shall have built-in, flush lifting eyes for ease of cover lifting. Bolted-on or U-bolt type devices shall not be acceptable as cover lifting eyes.
  13. Frames and covers shall be constructed of the materials as specified and in accordance the details shown on the plans and shall be placed carefully to the lines or grades indicated on the plans or as directed by the WRPE Designee. Covers shall be stamped "Power," "Control" "Telco" or "Comm." as applicable.
  14. Source Quality Control: Inspect structures according to ASTM C1037.
- D. **Trench marking Tape**: All duct banks shall be marked with marking tape. Tape shall run continuous in the trench 6 inches below the surface or as indicated on the drawings. Marking tape shall be bright orange or yellow colored tape. Lettering shall read "Power," "Control," or "Comm." as applicable.
- E. **Duct ball markers**: All duct banks/buried cables shall be marked with ball markers. Ball markers shall be placed two feet below finished grade, directly above the duct bank, a maximum of 200 feet apart along the trench end and at the beginning, middle and end of each curve of the duct banks as shown on contract drawings. Ball markers shall be 4" diameter, having self-leveling design and a passive-tuned antenna molded inside a plastic disc which is free-loading within a waterproof polyethylene shell. The ball marker shall have a range of four feet and color coded as follows:
1. Orange for "Communication".
  2. Red for "Power" and "Power/Communication".
  3. Blue for "Splices" and "Ends of Ductbanks".
- F. **Conduit and Duct**:
1. Rigid Steel Conduit (RSC): ANSI C80.1, galvanized
  2. Rigid Non-Metallic Conduit (PVC): Schedule 40 and 80 high impact, polyvinyl chloride, in accordance with Federal Specification W-C-1094 and Underwriters Laboratories Standards UL-651 and 651A.
- G. **Accessories**:
1. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.
  2. Grounding: Provide grounding in accordance with Section 16060 "Grounding and Bonding."
  3. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg F, withstands temperature of 300 deg F without slump, and adheres to clean surfaces of metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

### **PART 3 - EXECUTION**

- 3.1 **General**: Installation shall adhere to the requirements indicated on the construction plans and details and as specified below:
- A. **Underground Ducts For Electrical Utility Service**: PVC or Rigid steel conduit, encased in concrete or as indicated on Contract Drawings.
- B. **Underground Ducts For Telecommunications Utility Service**: PVC or Rigid steel conduit, encased in concrete or as indicated on Contract Drawings.



- 3.2 **Examination:** Examine site to receive ducts and handholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and handholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 **Conduit and Duct Installation**

- A. Install conduit and duct as indicated on drawings. Grading of pullboxes and associated interconnecting ducts shall be shown on the plans.
- B. **Slope:** All duct lines shall be laid so as to drain toward handholes, unless otherwise shown on the drawings. Pitch ducts minimum of 1 inches vertical per 100 feet to drain toward handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 handholes to drain in both directions.
- C. **Curves and Bends:** Manufactured bends shall have a minimum of 24 inches for a 2-inch duct and 48 inches for a 4-inch duct.
- D. **Joints:** Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. **Duct Entrances to Handholes:** Provide ground bushings where RGS ducts enter handholes.
- F. **Underground Warning Tapes:** Install above all underground conduit installations. Locate six (6) inches below finished grade.
- G. **Size:** Where no size is indicated on the plans, the ducts shall not be less than 4 inches inside diameter.
- H. **Concrete-Encased Ducts:** Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:
  - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Minimum separator spacing shall be 5 feet.
  - 2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other termination's in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of joint near the corners of the envelope.
  - 3. Reinforcing: Reinforce duct banks where they cross high traffic areas. Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
  - 4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.
  - 5. Minimum Clearances Between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 12 inches between power and signal ducts.
  - 6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches below finished grade.

7. In the event any obstructions are encountered, the Contractor shall inform the WRPE Designee immediately.
  8. Install trenches for duct banks in accordance with pertinent requirements of all sections of this Specification.
  9. Assemble duct joints with a solvent cement for conduit type and applied as directed by the manufacturer. Stagger any duct joints in the duct bank, both horizontally and vertically, a minimum of one foot to increase structural integrity of the duct bank installations. No two duct joints shall lie in the same transverse plane in a vertical or horizontal direction. These provisions shall also apply at all ducts installed for future extensions
  10. The Contractor shall notify the WRPE Designee at least six hours before starting to place backfill in any duct to permit the inspection of ducts and spacers. Where mechanical compactors are used, care shall be taken so as to not injure and displace the ducts.
- 
- I. **Stub-Ups:** Use rigid steel conduit for stub-ups to equipment. Install insulated grounding bushings on the terminations.
  - J. **Sealing:** Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
  - K. **Pulling Cord:** Polyolefin pull line with a minimum tensile strength of 200 pounds shall be provided in conduits installed for future use.
  - L. Joints in plastic conduit shall be made up in accordance with the manufacturer's recommendations for the particular type of conduit.
  - M. **Duct Cleaning:** Mandrel each duct. An iron-shod mandrel, not more than 1/4 inch smaller than the bore of the duct shall be pushed through each duct by means of jointed conduit rods. The mandrel shall have leather or rubber gasket slightly larger than the duct hole. The Contractor shall completely and thoroughly swab clean each duct prior to cable installation.
  - N. Conduit shall terminate in duct terminators where the duct lines enter handholes. Where conduit risers are exposed above grade or slab, convert to RGS including last elbow below grade.
  - O. Changes in direction of runs exceeding a total of 10 degrees, either horizontal or vertical, shall be accomplished by field preparation and installation of long sweep bends having a minimum radius of curvature of 25 feet, in order to avoid kinks in the conduit, except that manufactured bends may be used at the ends of the run. The long sweep bends may be made up of one or more curved or straight sections and/or combinations thereof.
  - P. Spare ducts at the entrance to handholes, shall be plugged with a removable tapered plug, designed by the duct manufacturer, or with hardwood plugs conforming accurately to the shape of the duct and having the larger end of the plug at least 1/4 inch greater in diameter than the duct.
    1. All ducts shall be securely fastened in place during construction and shall be plugged to prevent seepage of grout, water or dirt. Any duct section having a defective joint shall be repaired or replaced prior to backfill.

### 3.4 **Underground Utility Structure Installation**

- A. **Elevation:** Install handholes with roof of handhole at finished floor or grade. Install handholes with depth as required based on ductbank elevations and sloping requirements.



- B. **Access:** Install cast-iron frame and cover. Install handhole cover as indicated on Contract Drawings.
  - C. **Cast-In-Place Underground Structure Installation:** Conform to applicable requirements of Section 03301 "Cast-In-Place Concrete".
    - 1. Finish interior surfaces with a smooth troweled finish.
  - D. **Precast Underground Structure Installation:** Install as indicated on Contract Drawings and according to manufacturer's written instructions and ASTM C891.
    - 1. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.
    - 2. Support units on a level bed of crushed stone or gravel, graded from the 1-inch sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.
    - 3. Defects: Minor cosmetic defects in the concrete which do not affect the strength of the handhole, or expose the steel reinforcement, maybe accepted if the defects are properly patched and do not cover more than a total area of 4 square feet.
    - 4. Joints: The joints between different handholes shall provide a surface area of sufficient size and dimensions to provide adequate lateral strength and prevent moisture egress with the sealant provided by the manufacturer. All joints shall be on the horizontal plane with a maximum of two joints per box. The joint utilized between sections shall be as indicated in the Contract Drawings. The separation between different handhole sections at joints shall not vary more the 2 inches from the point of least separation to the greatest separation. Excess sealant shall be removed and surface projections shall be removed before backfill operations begin.
- 3.5 **Earthwork:** Excavation, Backfill and Compacting: Conform to Section 02325 "Excavating, Backfilling and Compacting for Utilities" but do not use heavy-duty hydraulic-operated compaction equipment.
- 3.6 **Restoration:** All areas disturbed by the trenching, storing of dirt, cable laying and other work shall be restored to its original condition in accordance with Division 2. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance.
- 3.7 **Field Preparation:** The Contractor shall prepare a hole large enough to accommodate the outside dimensions of the Structure as shown on the drawings.
- A. Prior to setting, the Contractor shall provide 6"-8" inches of 3/4 inch crushed stone as a base to receive the handhole.
  - B. The base material shall be compacted and graded level and at proper elevation to receive the handhole in proper relation to the conduit grade and ground cover requirements as shown on the plans.
  - C. After primary structure has been properly installed, excavation shall be backfilled.
- 3.8 **Miscellaneous Item Installation**
- A. Welding will not be permitted unless shown otherwise on the approved shop drawings. Equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the WRPE Designee and approval of the method of correction shall be obtained. Approved corrections shall be made at the Contractor's expense.



- B. **Anchor Bolts:** Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately. All miscellaneous items shall be galvanized.
- C. **Adjustment:** After assembly, the various members shall be aligned and adjusted accurately before being fastened.
- D. **Galvanizing touchup:** Apply liquid-cold galvanizing compound conforming to U.S. Navy Galvanizing Repair Specification MIL-P-21035 to galvanized surfaces damaged during installation. Surfaces shall be cleaned and compound applied in accordance with manufacturer's recommendation.
- E. **Grounding:** Install handhole grounding in accordance with Section 16060 "Grounding and Bonding."

**3.9 Field Quality Control**

- A. **Testing:** Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.
  - 2. Grounding: Test handhole grounding in accordance with Section 16060 "Grounding and Bonding."
  - 3. Duct Integrity: Rod ducts with a mandrel 1/4 inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.
- B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

**3.10 Cleaning**

- A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch greater than internal diameter of duct.
- B. Clean internal surfaces of handholes including sump. Remove foreign material.

**END OF SECTION**

**SECTION 16120**  
**WIRES AND CABLES**

**PART 1 - GENERAL**

**1.1 Summary:**

- A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.
- B. **Work shall include:**
1. Wire
  2. Multi-Conductor Cable
  3. Wire Connections and Terminations
  4. Ground Wire

**1.2 Reference Standards:**

Applicable only to the extent specified.

- A. **National Electrical Manufacturers Association (NEMA)**
1. WC70-00 Non-Shielded Power Cable 2000V or Less
  2. WC26-00 Binational Wire and Cable Packaging Standard
- B. **Federal Aviation Administration (FAA)**
1. FAA-C-1391b Installation and Splicing of Underground Cables
  2. C-1217f Electrical Work, Interior
  3. STD-019e Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment
  4. STD-020b Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment
- C. **Federal Specification (FS)**
1. W-S-610 Splice Connectors
  2. QQ-W-343 Wire, Electrical, Copper, Uninsulated
- D. **National Electrical Contractors Association (NECA)**
1. 1-2000 Standard of Installation
- E. **International Electrical Testing Association (NETA)**
1. ATS Acceptance Testing Specification for Electric Power Distribution Equipment and Systems
- F. **National Fire Protection Association (NFPA)**
1. 70 National Electrical Code (NEC), latest edition
- G. **Occupational Safety and Health Administration (OSHA)**
1. 29CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
- H. **Underwriters Laboratories (UL)**
1. 83 Thermoplastic-Insulated Wires and Cables
  2. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

- I. **American Society for Testing and Materials (ASTM)**
  - 1. B3 Standard Specification for Soft or Annealed Copper Wire
  - 2. B8 Standard Specification for Concentric-Lay Standard Copper Conductors, Hard, Medium Hard or Soft
  - 3. D753 Standard Specification for General Purpose Polychloroprene Jacket for Wire and Cable
- J. **Institute of Electrical and Electronic Engineers (IEEE)**
  - 1. 241 Recommended Practice for Electric Power Systems in Commercial Buildings
- K. **Insulated Cable Engineers Association (ICEA)**
  - 1. S-95-658 Nonshielded 0-2kV Cables
  - 2. S-105-692 600V Single Layer Thermoset Insulated Utility Underground Distribution Cable

**1.3 Submittals:**

- A. **Product Data:** Submit product data for each product specified.
- B. **Specifications:** Submit manufacturer's data on electric wire, cables, conductors, connectors, and connector crimping tools where specified.
- C. **Field Test Reports:** Submit field test reports indicating and interpreting test results relative to compliance with the performance requirements of the testing standard.

**1.4 Quality Control**

- A. **NFPA compliance:** Comply with NFPA 70, NEC, latest edition, for components and installation.
- B. **Listing and Labeling:** Provide products specified in this Section that are listed and labeled.
  - 1. The Terms "Listed and Labeled": As defined in the NEC, Article 100.
  - 2. Listing and Labeling Agency Qualifications: An NRTL as defined in OSHA Regulation 1910.7.
- C. **Installer Qualifications:** Cable splices shall be performed by experienced and qualified cable splicers. The workmen shall be licensed if required by the authority having jurisdiction.

**1.5 Sequencing and Scheduling**

- A. **Coordination:** Coordinate layout and installation of cable with other installations.
  - 1. Revise locations and elevations from those indicated as required to suit field conditions in coordination with the Work Release Project Engineer (WRPE) Designee.

**1.6 Delivery, Storage, and Handling**

- A. **Delivery:** Deliver all wire and cable products to the Project site in accordance with NEMA WC-26 and in their original packaging. Conductors with damaged insulation shall not be permitted.
- B. **Storage:** Store wire and cable products in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.
- C. **Handling:** Handle wire and cable products carefully to avoid abrading, puncturing, or tearing wire and cable insulation and sheathing. Ensure that the dielectric resistance integrity of wire/cable is maintained.



## **PART 2 - PRODUCTS**

### **2.1 General:**

- A. Materials procured in this Section shall be in accordance with FAA-C-1217f, FAA STD-019e, and FAA STD-020b.
- B. Unless otherwise indicated, wiring shall consist of 600 volt insulated, single conductor, copper conductor, installed in conduit. Conductor shall bear easily readable marking along the entire length, indicating conductor size and insulation type.

### **2.2 Wires and Cables**

- A. **Rating:** Provide UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3, "Applications" of this section.
- B. **Insulation – Above Grade and Interior Use:** THHW/THWN conforming to NEMA WC70. XHHW conforming to NEMA WC70. Insulation for conductors in shall be rated at 75 degrees C.
- C. **Insulation – Below Grade Use:** Conductors in contact with the earth or routed underground in conduit shall be type UF, XHHW-USE, RHW-USE, XLP-USE, or of a multiconductor armored construction with equivalent outer insulation.
- D. **Characteristics:**
  - 1. All wire, conduit sizes, and ampacities are based on copper conductors, 75 degrees C insulation.
  - 2. Conductivity shall not be less than 98 percent at 20 degrees C (68 degrees F) or resistivity greater than 1.7 microohms per centimeter.
  - 3. Provide solid conductors for #10 AWG and smaller, stranded conductors for larger than #10 AWG.
  - 4. Stranded conductors smaller than #10 AWG are allowed in applications where vibration and flexing may be encountered.
  - 5. All control wiring shall be stranded.
- E. **Size:**
  - 1. Minimum power conductor size shall be #12 AWG.
  - 2. Minimum conductor size shall be #10 AWG for 120 volt circuits where circuit length (one way) exceeds 75 feet from source, and #8 AWG for 120 volt circuits where circuit length (one way) exceeds 150 feet from source.
  - 3. Communication/control systems wiring size shall be in accordance with Manufacturer's requirements.
  - 4. Minimum control wire size shall be #14 AWG unless otherwise noted.
- F. **Color Code:** Conductors smaller than #4 shall be factory color coded. Color coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable. If there is no standard color coding at the facility, conductors shall be color coded as follows:

1. AC power wiring

**Three Phase**

**120/240 Volt System**

- |            |       |
|------------|-------|
| a) Line 1  | Black |
| b) Line 2  | Red   |
| c) Neutral | White |

**Single Phase**

**120 Volt System**

- |            |       |
|------------|-------|
| 1) Line    | Black |
| 2) Neutral | White |

2. Equipment Grounding Conductor: Green (for all systems)
3. Control Wiring
  - a. Ungrounded conductor wiring Violet
  - b. Grounded conductor wiring White
5. Control Cables shall be color coded in accordance with IAW NEMA WC70.

**G. Uninsulated Conductors:** For uninsulated conductors refer to Section 16060, "Grounding and Bonding."

**H. Prohibited Wire Products:** The use of non-metallic sheathed cable types NM to NMC, armored-bushed cable (BX), and armor-clad cable (AC) is prohibited.

**I. Control Cable:**

1. Contractor-furnished control cable shall be in accordance with Section 3.1.2 of FAA-C-1391b, and with Rural Utilities Service 7 CFR 1755.390 (REA PE-39). This cable shall have a core consisting of 19 gauge size (AWG) solid copper conductors with thermoplastic or thermosetting insulation color-coded per telephone industry standards. The core shall be completely filled with ETPR compound. The outer sheath shall have a corrugated copper shield applied longitudinally around core. The outside jacket shall be black polyethylene. It shall be a standard product of a major cable manufacturer, and shall be rated for outdoor, direct-earth burial use.

**J. HELIAX Coaxial Cables**

1. Coaxial cable shall be Heliac foam dielectric cable manufactured by Andrew Corp, Orland Park, Illinois 708-349-3300.
2. ½ inch coaxial Heliac cable shall be Andrew product number LDF4 – 50A. This is a low-loss foam-dielectric, Heliac coaxial cable.
3. Due to its reliable history in FAA Southern Region compared with other products with similar characteristics, and its compatibility with cable connectors used by the FAA, no substitutions of another brand will be allowed for Heliac cable.

**2.3 Connectors and Splices**

- A. Connectors:** Provide UL-listed factory-fabricated wiring connectors of size, ampacity and temperature rating, material, type and class required by NFPA and NEMA standards for application and for services indicated. Select connectors to comply with the project's installation requirements and as specified in Part 3, "Applications."
1. For conductor sizes #10 AWG and smaller, provide 600V solderless, insulated pressure cable connectors, of the compression or indent type, or wire nut connectors.
  2. For cable sizes #8 AWG and larger provide long barrel type compression connectors.
  3. Stranded conductors may be used with wire compression connectors or a pressure washer type lug.



**B. Splices:**

1. **Splice Envelopes:**
  - a. Power cables 600 volts and below: Cast or pressure epoxy resin splice envelopes or equal, or taped splice using a prestretched or heat-shrinkable tubing covering. Known acceptable source for all direct earth burial cable: 3M Co. or approved equal.
  - b. Control and telephone cables: Re-enterable filled splice envelope, Scotch brand 3925 or approved equal.
2. **Splice Material:** Provide all insulating materials for splices and connections such as glass and synthetic tapes, putties, resins, splice cases or compositions of the type approved for the particular use, location, voltage and temperature and apply and install in an approved manner, all in accordance with the manufacturer's recommendations.
4. **Insulating Tape:** Provide plastic electrical insulating tape that is flame retardant and cold weather resistant. Tape to be used in areas that are subject to 30 degrees C to 105 degrees C, or where the tape will be subjected to an oil splash, shall have a minimum thickness of 8.5 mils, and shall consist of an oil-resistant vinyl backing with an oil-resistant acrylic adhesive.

**C. Underground Taps:** Waterproof and rated for application.

**PART 3 - EXECUTION**

- 3.1 **Examination:** Examine raceways that are to receive wires and cables for compliance with installation tolerances and other conditions. Verify that the duct or conduit is open, continuous, and clear of debris before installing cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 **Applications**

- A. **Grounded Conductors:** In single-phase systems (120 volt two-wire and 120/240 volt three-wire), one grounded conductor (neutral) shall accompany each ungrounded phase conductor (120 volt systems) or ungrounded phase conductor pair (120/240 volt systems) powered from a circuit-interrupting device. In three-phase (Y-connected, 4-wire) systems, one grounded neutral conductor shall accompany the three related ungrounded conductors fed from a circuit interrupting device. All neutral conductors shall extend from the neutral bus in the power source. Device terminals for connection of more than one conductor shall be specifically designed for that purpose.
- B. **Bundling:** Neatly and securely bundle all conductors #10 AWG and smaller located in branch circuit panelboards. Neatly secure cable in individual circuits for all conductors larger than #10 AWG located in pull boxes. Bundle cable with wire ties.

3.3 **Installation**

- A. **Conductors and Cables:**
  1. Materials installed in this Section shall be in accordance with FAA-C-1217f, FAA STD-019e, and FAA STD-020b.
  2. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation." Tag all conductors at their termination in accordance with Section 16195, "Electrical Identification."
  3. Pull conductors into raceway simultaneously when more than one is being installed in the same raceway.
    - a. Use wire pulling compound or lubricant as required. Compound used must not



- deteriorate the conductor or insulation, and must be non-flammable.
  - b. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage the cables or raceway.
  - 4. Cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering.
  - 5. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
  - 6. The ends of cables shall be sealed with moisture-seal tape before pulling, and shall be left sealed until connections are made.
- B. **Conductor Splices:**
- 1. Splices shall be made at outlets, junction boxes, pull boxes, or accessible raceways only.
  - 2. Splices shall be made with solderless connectors conforming to FS W-S-610, UL-486A, UL-486C, and UL-486E.
  - 3. Wire nuts may only be used to splice conductors sized #10 AWG and smaller.
  - 4. Compression connectors shall be used to splice conductors #8 AWG and larger. Use proper tool to provide circumferential pressure connection.
  - 5. All splices, including those made with insulated wire nuts, shall be insulated with electrical tape or heat-shrink tubing to a level equal to that of the factory insulated conductors.
  - 6. Splicing of ungrounded conductors in panelboards is not permitted.
  - 7. Install splices and insulating tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
  - 8. Use splice and tap connectors that are compatible with conductor material.
  - 9. Splicing methods and material shall be of a type recommended by the manufacturer of the splicing material for the particular type of cable being spliced, and shall be approved by the WRPE Designee prior to installation.
  - 10. Conductors of different color insulation shall never be spliced together.
  - 11. Keep conductor splices to a minimum.
  - 12. Splice 600V conductors in pull boxes only.
  - 13. A splice shall not be pulled into a duct or a conduit under any circumstances.
  - 14. Install waterproof taps in underground structures.
- C. **Conductor Identification:** For conductors #4 AWG and larger, color code in accordance with this Section and Section 16195, "Electrical Identification."
- 1. All line, phase, and neutral conductors shall have their source and circuit labeled.
  - 2. Conductor identification shall be provided at all terminations, in all junction boxes through which these conductors pass, and within each enclosure where a splice, tap, or termination is made.
  - 3. Terminal and conductor identification shall match at both ends of the run, as on approved shop drawings.
- D. **Wiring at Outlets:** Install with at least 12 inches of slack conductor at each outlet for connection to equipment. Identify all conductor circuit numbers at terminals and junction points.
- E. **Connections at Outlets:** Connect outlets and components to wiring and to ground as indicated on shop drawings. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.
- F. **Large Conductors:** Cables/conductors sizes 250 kcmil and greater shall be installed with the use of a hydraulic cable bender where installed exposed (e.g. manholes). Cable supports shall be required for stress relief.
- G. **Grounding:** Grounding shall be installed in accordance with section 16060, "Grounding and Bonding."

- H. **Shared Neutrals and Grounds:** Separate neutral and ground wires shall be provided for each overcurrent protection device. Shared/common neutrals are not allowed. Install a separate neutral wire per phase for all lighting and power outlet circuits.
- I. **Termination:** Provide compression type termination lugs where mechanical lugs included with equipment do not comply with FAA STD-1217f, Paragraph 4.6.5.2.
- J. **Phasing:** The phasing of the complete electrical installation shall be connected and consistently maintained throughout the power distribution system. The phasing shall be A, B, C, in the clockwise direction.
- K. **Conductor Supports:** The contractor shall provide conductor supports as required by the NEC and recommended by the cable manufacturer. Where required, route vertical conductor runs in conduit.
- L. **Conductors and Slack:** Provide all conductors and connectors necessary for a complete installation from the point of service connections to all devices shown on the drawings, in schedules, and in the specifications. Provide ample slack wire for all connections.

### 3.4 **Field Quality Control**

- A. **Testing, General:** Cables shall be tested prior to installation and again upon completion of the installation. Testing shall also be performed prior to termination. Tests shall be performed in the presence of the WRPE Designee.
  - 1. Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.
  - 3. Test wire and cable for continuity of circuitry, proper phasing, and also for short circuits.
- B. **Insulation Resistance Tests:** Feeder and Branch Circuit insulation tests shall be performed after installation, but before connection to equipment.
  - 1. Conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 megohms when measured with a 500-volt DC insulation resistance tester. The contractor shall submit a letter type test report to the WRPE Designee prior to final inspection of the Work. The report shall list the tests performed and results obtained.
  - 2. Apply the test voltage for at least one minute after motor reading has stabilized.
  - 3. Contractor shall use "FAA megger form" located at the end of this Section to record megger readings.
- C. **Corrections:** Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

**FAA MEGGAR FORM**  
**Field Test Record Meggar Readings**  
**(Power and Control Wire/Cable)**

Project Name \_\_\_\_\_  
Project No. \_\_\_\_\_

Date \_\_\_\_\_ Sheet No. \_\_\_\_ of \_\_\_\_  
Address \_\_\_\_\_

NOTE: MEGGAR ALL PHASES, RECORD MINIMUM READING.

Panel No. Ckt. No. Feeder No.	WIRE TAGGING	VOLT.	WIRE OR CABLE				MEGOHMS	SUPERVISOR O.K.
			NO.	SIZE	FROM	TO		

DISTRIBUTION: WRPE Designee  
CONTRACTOR  
WRPE  
File

\_\_\_\_\_  
WRPE Designee / Date

\_\_\_\_\_  
Contractor Supervisor / Date

**END OF SECTION**



**SECTION 16130**  
**RACEWAYS, FITTINGS, BOXES, AND CABINETS**

**PART 1 - GENERAL**

**1.1 Summary**

- A. This Section includes furnishing material, equipment, labor and incidentals necessary to install a complete and operational system of raceways, fittings, boxes, enclosures, and cabinets for each type of electrical system.
- B. **Types of raceways in this Division include the following:**
1. PVC coated rigid steel.
  2. Polyvinyl chloride conduit (PVC).
  3. Rigid steel (metal) conduit, zinc coated (RGS or RSC).
  4. Electrical metallic tubing (EMT).
  5. Liquidtight flexible metal conduit.
- C. **Types of boxes, enclosures, and cabinets in this Division include the following:**
1. Outlet boxes.
  2. Pull and junction boxes.
  3. Cabinets and enclosures with hinged covers.

**1.2 Reference Standards:** The current issues of the following documents in effect on the date of the Request-For-Offers from part of this Specification and are applicable to the extent specified herein:

- A. **American National Standards Institute (ANSI)**
1. C80.1 Rigid Steel Conduit, Zinc-Coated RGS.
  2. C80.3 Electrical Metallic Tubing, Zinc-Coated (EMT).
  3. C80.6 Intermediate Metal Conduit (IMC) Zinc-Coated
  4. 870 Wireways, Auxiliary Gutters and Associated Fittings
- B. **Federal Aviation Administration (FAA)**
1. STD 019e Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities.
  2. STD 020b Transient Protection, Grounding and Shielding Requirements for Electronic Equipment.
  3. C-1217f Electrical Work, Interior.
- C. **Federal Specifications (FS)**
1. W-C-586 Conduit Outlet Boxes, Bodies, and Entrance Caps.
- D. **National Electrical Contractors Association (NECA)**
- E. **National Electrical Manufacturers Association (NEMA)**
1. FB1 Fitting, Cast Metal Boxes, and Conduit Bodies, and Cable Assemblies
  2. OS1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
  4. 250 Enclosures for Electrical Equipment (1000 Volts and Below)
  5. ICS-6 Industrial Control System Enclosure.
  6. RN1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

**F. National Fire Protection Association (NFPA)**

1. 70 National Electrical Code (NEC), latest edition

**G. Occupational Safety and Health Administration (OSHA)**

1. 29CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

**H. Underwriters Laboratories (UL). Materials having UL listing shall bear the UL label.**

1. 6 Rigid Metal Conduit
2. 50 Enclosures for Electrical Equipment
3. 360 Liquid-tight Flexible Metal Conduit
4. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
5. 514A Metallic Outlet Boxes
6. 514 B Fittings for Conduit and Outlet Boxes
7. 797 Electric Metallic Tubing
8. 870 Wireways, Auxiliary Gutter, and Associated Fittings.
9. 1242 Intermediate Metal Conduits
10. 651 PVC Conduit

**I. Steel Structures Painting Council (SSPC)**

1. PS-10.01 Hot-applied coal tar enamel painting system.

**1.3 Submittals:** Submit manufacturer's product data for all raceway and fittings, floor boxes, hinged cover enclosures, and cabinets. Include specifications, installation instructions and general recommendations.

**1.4 Applications:**

- A.** Boxes shall be provided in the wiring and raceway system for pulling wires, making connections.

**1.5 Quality Control**

- A.** Comply with latest edition of the NFPA 70 "National Electrical Code" latest edition for components and installation.

1. Boxes shall be sized in accordance with NEC Article 370.

**B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.**

1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

- C.** Comply with NECA "Standard of Installation."

- D.** Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

**1.6 Shop Drawings:** Submit dimensioned drawings of raceway and wireway systems showing layout of raceway at all congested areas such as above and below panelboards.

## **PART 2 - PRODUCTS**

### **2.1 General:**

- A. Enclosures shall conform to NEMA standards.
- B. All materials procured under this specification shall be in accordance with FAA C-1217f, FAA STD-019e and FAA STD-020b.
- C. **Raceway size:** Raceways shall be adequately sized to include the phase conductors, an equipment ground conductor (green) and a neutral conductor (gray or white) in accordance with percentage fill requirements by NFPA 70 (NEC) latest edition. Note: Per FAA-STD-019e, equipment grounding conductors are sized the same as phase conductors, impacting raceway size.
  - 1. Provide 3/4 inch conduit minimum unless otherwise indicated on Contract Drawings.

### **2.2 Conduit and Tubing**

- A. **Rigid Steel Conduit:** Heavy wall mild steel tube with metallic corrosion resistant coating on exterior and interior, hot dipped galvanized steel, free from defects; Manufactured in accordance with Federal Specification W-C-581, ANSI C80.1 and UL 6.
- B. **PVC Coated Steel Conduit:** Meeting the requirements of Rigid Steel Conduits; 40mil PVC exterior coating and red urethane interior coating, in accordance with NEMA RN 1.
- C. **Electrical Metallic Tubing:** Welded steel tubing, formed of low carbon steel, electro-galvanized exterior, inside coated with a baked, elastic low-friction coating of enamel, in accordance with Fed. Spec. WW-C-563, ANSI C80.3 and UL 797.
- D. **Liquidtight Flexible Metal Conduit; Flexible steel conduit with PVC jacket:** Liquidtight conduit shall have an extruded, polyvinyl jacket over the flexible metal in accordance with UL 360
  - a. Flexible non-metallic conduit shall not be used.
- E. **Rigid Non-Metallic Conduit (PVC):** Schedule 40 and 80 high impact, polyvinyl chloride, in accordance with Federal Specification W-C-1094 and UL 651 listed.

### **2.3 Raceway Fittings, Couplings and Connectors**

- A. **Material:** Use fittings listed and approved for specific conduit or raceway system used.
- B. **Bushings and connectors:** Bushings and connectors shall be insulated type which maintain continuity of conduit ground system. Insulating material shall be molded or locked into metallic body of the fitting. Bushing made entirely of nonmetallic material will not be allowed.
- C. **Fittings and Conduit Bodies:** UL 514B and NEMA FB 1, compatible with conduit and of the threaded type.
  - 1. **Rigid Steel Conduit:** Threaded type material to match the conduit, in accordance ANSI/NEMA FB1.
  - 2. **Rigid Non-Metallic Conduit:** Solvent-welded, slip-on joints.
  - 3. **Below Grade Installations:** For installation below slab, on-grade, or underground, the conduit shall be factory coated with either 0.008 inch of epoxy, 0.020 inch of polyvinyl chloride or 0.063 inch of coal-tar enamel or shall be field wrapped with 0.01 inch thick pipe wrapping plastic tape applied with 50% overlap.



4. Electrical Metallic Tubing: Fittings used with EMT shall be compression-type fittings designed for this type of conduit, unless otherwise indicated. Screw-type fittings are not acceptable. Connectors shall have insulated-throat, smooth bell shaped end or a bushing.
5. Set Screw fittings are not allowed.
6. Elbows and Bends: Rigid and nonmetallic conduit system shall use factory elbows and bends for conduits 2 inches and larger for all bends greater than 45 degrees. Other conduit systems shall use the same material as the conduit with which they are installed.
7. Bushings: High impact, thermosetting, phenolic insulation, 150 degrees C.
8. Ground Bushing: Shall consist of a malleable iron, insulated throat conduit bushing with an attached setscrew lug.
9. Locknuts: Zinc-plated or Cadmium-plated, malleable iron.
10. Threaded Nipples: Conduit nipples shall have two independent sets of thread.
11. Hubs: Cadmium-plated, malleable iron with tapered threads and neoprene "O" ring.

- D. Liquid-tight Flexible Metal Conduit Fittings: Liquid-tight flexible metal conduit fittings shall be made of galvanized steel. They shall be insulated and one of the following types:
1. Wedge and screw type having an angular wedge fitting between the convolutions of the conduit.
  2. Squeeze or clamp type having a bearing surface contoured to wrap around the conduit and clamped by one or more screws.
  3. Steel, multiple point type, for threading into the internal wall of the conduit convolutions.

E. Inferior material such as "pot metal" shall not be used for any type of fitting.

F. All locknuts shall be of the bonding type with sharp edges for digging into the metal wall of the enclosure.

#### 2.4 Outlet Boxes

- A. Sheet Metal Boxes: NEMA OS 1 and UL 514A; Galvanized steel with 1/2 inch male fixture studs where required.
- B. Cast Metal Boxes: NEMA FB 1, type FD, cast alloy box with gasketed cover, threaded hubs. Use cast boxes for damp and outdoor locations.
- B. Fittings: UL 514B

#### 2.5 Pull and Junction Boxes:

- A. Small Sheet Metal Boxes: NEMA OS 1 and UL 514A.
- B. Cast Metal Boxes:
1. Threaded-hub type conforming to UL 514A and UL 514B.
  2. Galvanized steel conforming to UL 514A and UL 514BB
- C. Covers: Class 30B gray cast iron conforming to ASTM-8, machine finished with flat bearing surfaces.

#### 2.6 Interior/Exterior Cabinets and Enclosures

- A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.

- B. Cabinets and enclosures:** NEMA 250, code gauge galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.
1. Cabinets and enclosures shall be constructed with interior dimensions not less than those indicated on the Contract Drawings.
  2. Provide 5/8 inch plywood backboard unless otherwise indicated.
  3. Key latch to match panelboards. Provide two keys with each cabinet unless otherwise notified.
  4. Interior cabinets and enclosures shall be rated NEMA 1.
  5. Exterior cabinets and enclosures for power equipment shall be rated NEMA 3R.
  6. Exterior cabinets and enclosures for splice/communication/control shall be rated NEMA 4X (fiberglass).
- C. Safety:** UL 50
- D. Locks:** All locks in this project shall be keyed alike.

### **PART 3 - EXECUTION**

#### **3.1 Preparation**

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine raceways prior to installation. No crushed or deformed raceway shall be installed.
- C. Provide electrical boxes in locations shown on the plans and as required for splices taps, wire pulling equipment connections and code compliance.

#### **3.2 Wiring Methods**

- A. Outdoors:** Use the following wiring methods:
1. Underground Encased Concrete Ductbank: Rigid galvanized steel conduit and fittings.
  2. Exposed: Rigid steel conduit, unless otherwise indicated on Contract Drawings.
  3. Underground, Single or Grouped Run: Rigid steel/PVC conduit and fittings as indicated on Contract Drawings.
  5. Connection to Vibrating Equipment (including transformers) liquid-tight flexible metal conduit.
  6. Boxes and Enclosures: NEMA Type 3R and/or Type 4X, as specified in Part 2.
- B. Indoors:** Use the following wiring methods:
1. Connection to Vibrating Equipment: Flexible metal conduit, except in wet or damp locations, use liquid-tight flexible metal conduit.
  2. Damp or Wet Locations: Rigid steel conduit.
  3. Exposed: Rigid steel conduit. Rigid steel conduit shall be used in the electrical/mechanical rooms to a height of 8 feet above finished floor.
  4. Boxes and Enclosures: NEMA Type 1.
- C. Conduit Use:**
1. Install rigid steel conduit (RSC) for all distribution panel feeders, transformer feeders.



2. Use rigid steel or PVC conduit and fittings for underground ductbanks as indicated on Contract Drawings.
3. Use PVC coated rigid galvanized steel conduit for all conduit systems installed in contact with earth.
4. Ends of conduit systems not terminated in boxes or cabinets shall be capped.
5. Where conduits enter enclosures without hubs, an appropriate connector with threads and locknuts shall be used to securely bond the conduit to the enclosure.
6. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure. In addition, the connector shall be the insulated-throat type.
7. EMT may be used only in dry interior locations, and where not subject to physical damage.
8. EMT shall not be used on circuits above 600 volts or in sizes greater than 4 inches in diameter.
9. EMT shall be used above grade in conjunction with frangible fittings as indicated on Contract Drawings.

### 3.3 **Installation:**

- A. Products shall be installed in accordance with FAA C-1217f, FAA STD-019e, and FAA STD-020b.
- B. **Conduit:**
  1. Minimum size for conduit power circuits shall be 3/4 inch, unless otherwise noted.
  2. Conduit for telephone and signal systems shall be as follows:
    - a. 1/2-inch conduit may be used for lengths not exceeding 50 feet. 3/4-inch conduit may be used for lengths not exceeding 100 feet.
    - b. 1-inch conduit shall be used for lengths exceeding 100 feet.
  3. No run shall contain more than four (4) 90-degree bends, or the equivalent between boxes. Provide pull and junction boxes required to meet this criteria.
  4. Size conduits as required by the NEC for the number and sizes of wires to be pulled into the conduit.
  5. Use conduit bodies to make sharp changes in directions around ground beams.
  6. Use temporary closures/caps to prevent foreign matter and moisture from entering conduit.
  7. Use conduit fittings suitable for use and location.
  8. Conduit under/embedded in slabs: Install in middle third of the slab thickness where practical, and leave at least 1 inch concrete cover.
    - a. Secure conduit to reinforcing rods to prevent sagging or shifting during concrete placement.
    - b. Space conduit laterally to prevent voids in the concrete.
    - c. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
  9. For installation below slab, on-grade, or underground, the Rigid Steel Conduit shall be PVC coated, 0.063 inch of coal-tar enamel or shall be field wrapped with 0.01 inch thick pipe wrapping plastic tape applied with 50% overlap. Fittings used underground shall be protected by field wrapping as specified herein for conduit.
  10. Field Cut Conduit: Where conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. The cut ends of the field-cut conduit shall be reamed to remove burrs and sharp edges.
  11. Field Threaded Conduit: Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimension and taper as specified for factory-cut threads on conduit.
  12. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, or where conduits enter enclosures



- without threaded hubs, use two locknuts, one inside and one outside the box to securely bond the conduit to the enclosure.
- a. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
13. Bushings: Install a bushing on the interior threaded end of each conduit to protect conductor insulation.
  14. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Where space conditions prohibit the use of standard elbows, use ferrous alloy fittings to, match the conduit construction. "Condulet" type fittings shall not be used on conduits containing # 4 AWG or larger wire.
    - a. Bends in conduit that is 1 inch and larger shall have a minimum inside radii 12 times the nominal conduit diameter.
  15. Frangible Couplings: The point of frangibility shall be located no higher than 3-inches above grade when installed.
- C. Complete raceway installation before starting conductor installation. Inside of raceways shall be reamed, deburred, fished and swabbed before conductors are pulled.
- D. **Support:** Support raceways, boxes, cabinets and enclosures in accordance with Section 16190 "Supporting Devices."
- E. **Floor and Wall Penetrations:**
1. Penetrations through walls or floors separating the building interior from the exterior shall be sealed to prevent moisture and rodent entry and to deter air transfer.
  2. Seal penetrations of walls which separate individually temperature or humidity controlled areas, to prevent air circulation.
  3. Conduit sealing methods and sealants shall be in accordance with the NEC.
  4. Conceal conduit unless otherwise indicated, within finished walls and ceilings.
- F. **Exposed Raceways:** Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
1. Run parallel or banked raceways together, and on common supports where practical.
  2. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
  3. Install raceways at proper elevations. Provide adequate headroom.
- G. **Joints:** Join raceways with fittings designed and approved for the purpose and make joints tight.
1. Use bonding locknuts and bushings at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  2. Use insulating bushings for all conduits to protect conductors.
- H. **Pull Wire:** Install pull wires in empty raceways. Use #14 AWG zinc-coated steel or monofilament plastic line having not less than 200-LB tensile strength. Leave not less than 24 inches of slack at each end of the pull wire.
- I. **Stub-Up Connections:** Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. Flexible conduit may be used 6 inches above the floor/pad in coordination with Work Release Project Engineer (WRPE). Where equipment connections are not made under this Contract, install screwdriver-operated

threaded flush plugs flush with floor. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

**J. Flexible Connections:**

1. Flexible, liquid tight metal conduit:
  - a. Use maximum of 6 feet of flexible conduit for equipment subject to vibration, noise transmission, or movement; in wet or damp outdoor locations; and for all motors.
  - b. May be used for branch circuits in lengths longer than 6 feet in computer room locations which meet requirements of NEC Article 645.
  - c. Fittings and junction boxes shall be liquid tight under raised floors.
2. A separate ground conductor shall be provided across all flexible conduit in addition to the equipment ground conductor run in the conduit with its related power conductors. This conductor shall be bonded to the connecting device at each end of the flexible conduit.

**N. Boxes:**

1. Shall be provided in the wiring or raceway system for pulling wires, making connections, and mounting devices and fixtures. Each box shall have the volume required by the NFPA 70 for the number and size of conductors in the box.
  - a. Pull/Junction Boxes: Installation shall be plumb and level. Bring pull boxes tops flush with finished grade. Install type suitable for location (interior/exterior, dry/damp/wet).
  - b. Outlet Boxes: Each outlet box shall have a machine screw which fits into a tapered hole into the box for the ground connection
  - c. Wet locations: Cast metal boxes installed in wet locations and boxes installed flush with exterior surfaces shall be gasketed.
  - d. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
  - j. Support boxes in accordance with Section 16190 "Supporting Devices." Minimum support shall be at each corner.
  - k. EMT entering an enclosure without threaded hubs: Provide a connector with threads and cast or machine lockout. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure.
  - l. Ends of conduit not terminated in boxes or cabinets shall be capped to protect against entry of dirt and moisture.
  - m. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors in accordance with other sections of the specification.
1. Contractor shall coordinate with other trades and shall determine proper placement and mounting heights of all devices.

3.4 **Grounding:** Install grounding connections for raceway, boxes, and components in accordance with Section 16060.

**3.5 Protection**

Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

**3.6 Adjusting and Cleaning**

- A. Upon completion of installation of system, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and cover

raceways and boxes to prevent entrance of foreign matter, paint, etc.

- B. Remove dirt and construction debris from outlet, junction, and pull boxes, and cabinets.
- C. Deformed raceways, boxes, cabinets and enclosures shall be replaced.
- D. Run a swab or mandrel to remove dirt or blockages from raceways.

**END OF SECTION**



**SECTION 16190**  
**SUPPORTING DEVICES**

**PART 1 – GENERAL**

**1.1 Summary**

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Types of supports, anchors, sleeves, seals and fastenings specified in this Section include the following:
  - 1. Clevis hangers
  - 2. C-Clamps
  - 3. Toggle bolts
  - 4. One-hole conduit straps
  - 5. Two-hole conduit straps
  - 6. Wall and floor seals

**1.2 Reference Standards**

Applicable only to the extent specified.

- A. **Federal Aviation Administration (FAA)**
  - 1. C-1217f Electrical Work, Interior
  - 2. STD-019e Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment.
  - 3. STD-020b Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment.
- B. **National Fire Protection Association (NFPA)**
  - 1. 70 National Electrical Code (NEC), latest edition
- C. **American Standard for Testing and Materials (ASTM)**
  - 1. A1011 SS GR 33 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

**1.3 Submittals:** Product data for each type of product specified.

**1.4 Quality Control**

- A. **Electrical Component Standard:** Components and installation shall comply with NFPA 70, (NEC) latest edition.
- B. Electrical components shall be listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

## **PART 2 – PRODUCTS**

- 2.1 **General:** Materials procured and installed in this Section shall be in accordance with FAA-C-1217f, FAA STD-019e, and FAA STD-020b.
- 2.2 **Coatings:** Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.
- 2.3 **Manufactured Supporting Devices**
- A. **Raceway Supports:** Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps comply with NEC, latest edition and the following requirements:
1. Conform to manufacturer's recommendation for selection of supports.
  2. Strength of each support shall be adequate to carry the design load plus 25 percent for future use, multiplied by a safety factor of at least of four. Where this determination results in a safety of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
- B. **Fasteners: Types, materials, and construction features as follows:**
1. Expansion Anchors: 1/2 inch lead expansion anchors approximately 38 pounds per 100 units.
  2. Toggle Bolts: 3/16 inch by 4 inch spring head toggle bolts approximately 5 pound per 100 units.
  3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. **Channel Systems (U-Channel):** Conform with A1011 SS GR 33. 16-gauge channels, stainless steel type 304 for outdoor locations, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.
- D. **Conduit Sealing Bushings:** Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in conduits subject to exposure to water and/or oil penetration at conduit joints. Provide plugs with number and size of conductor gripping holes as required to suit installation. Construct body of malleable iron casting with hot-dipped galvanized finish.
- E. **Conduit Sleeves and Seals:** Provide conduit sleeves and seals of types, sizes and materials indicated with the following features:
1. Provide factory-assembled watertight wall and floor seals of types and sizes suitable for sealing conduit, pipe, or tubing passing through concrete floors and walls. Construct with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.
- F. **Continuous Slotted Channels:** Dimensions as required for loads imposed.
- G. **Clamps:** Sized for application.

**2.4     Fabricated Supporting Devices**

- A.     **General:** Shop or field-fabricated supports or manufactured supports assembled from U-channel components.
- B.     **Steel Brackets:** Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C.     **Pipe Sleeves:** Provide pipe sleeves for steel pipe to be fabricated from Schedule 40 galvanized steel pipe.
- D.     Supporting devices shall meet seismic requirements of Zone 2B.

**PART 3 – EXECUTION**

**3.1     Installation**

- A.     Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B.     Coordinate with the building structural system and with other electrical installation.
- C.     **Raceway Supports: Comply with the NEC and the following requirements:**
  - 1.    Conform to manufacturer's recommendations for installation of supports.
  - 2.    Space supports for raceways in accordance with the NEC.
  - 3.    Support exposed and concealed raceway within 3 feet of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
  - 4.    In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D.     **Miscellaneous Supports:** Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- E.     **Cable Supports:**
  - 5.    Install in strict compliance with manufacturer's instructions.
  - 6.    Spacing not to exceed NFPA 70, latest edition, tabulation for spacing of conductor supports.
  - 7.    Allow adequate slack in conductors to prevent any stress on terminations. Take into consideration conductor thermal contraction.
  - 8.    Train cables for a neat and orderly installation.
- F.     **Sleeves:** Install in concrete slabs and walls for raceways and cable installations. Tighten sleeve seal nuts until sealing grommets have expanded to form a watertight seal.



- G. Fastening:** Unless otherwise indicated, fasten electrical items (including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, lighting fixtures and control components) and their supporting hardware securely to the building structure in accordance with the following:
1. Toggle bolts on hollow masonry units;
  2. Concrete inserts or expansion bolts on concrete or solid masonry;
  3. Machine screws, welded threaded studs, or spring-tension clamps on steel.
  4. Sheet metal screws in partitions of light steel construction.
  5. Threaded studs, driven by a powder charge and provided with lock washers and nuts, may be used instead of expansion bolts and machine or wood screws.
  6. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures.
  7. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
  8. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.
- H. Loads** applied to any fastener shall not exceed one-fifth of the proof test load.
- I. Tests:**
1. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
    - a. Expansion anchors.
    - b. Toggle bolts.
    - c. Powder-driven threaded studs.

**END OF SECTION**

**SECTION 16195**  
**ELECTRICAL IDENTIFICATION**

**PART 1 - GENERAL**

**1.1 Summary**

- A. This Section includes identification of electrical materials, equipment, and associated installation. It includes requirements for electrical component identification, including but not limited to the following:
1. Buried electrical line warnings
  2. Identification labeling for raceways, cables, and conductors
  3. Equipment labels and signs
  4. Panel Schedules

**1.2 Reference Standards**

Applicable only to the extent specified.

- A. **American Standards Institute (ANSI)**
1. A13.1 Scheme for the Identification of Piping Systems
- B. **Federal Aviation Administration (FAA)**
1. C-1217f Electrical Work, interior
- C. **National Fire Protection Association (NFPA), latest edition**
1. 70 National Electrical Code (NEC), latest edition

**1.3 Submittals**

- A. **Product Data:** Product Data for each type of product specified.
- B. **Schedule:** Schedule of identification nomenclature, abbreviations and equipment designations to be used for identification signs.
- C. **Samples:** Samples for each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.
- D. **Text:** Size and lettering text on each nameplate.

**1.4 Quality Control**

- A. **Electrical Component Standard:** Components and installation shall comply with NFPA 70 latest edition.
1. ANSI Compliance: Comply with requirements of ANSI standard A13.1, "Scheme for Identification of Piping Systems", with regard to type and size of lettering for raceway and cable labels.
  2. National Fire Protection Association (NFPA): Comply with NFPA 70, latest edition, requirements for Identification and for provision of warning and caution signs for wiring and equipment.

- 1.5 **Sequencing and Scheduling:** Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

## **PART 2 - PRODUCTS**

### **2.1 General**

- A. Materials shall be in accordance with FAA C-1217f.
- B. Except as otherwise noted provide manufacturer's standard products of categories and types required for each application.
- C. **Lettering, Colors, and Graphics:** Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Provide numbers, lettering and wording as approved in submittals as required by code or as recommended by the manufacturer.

### **2.2 Raceway and Cable Labels**

- A. **Manufacturer's Standard Products:** Where more than one type is listed for a specified application, selection is Contractor's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. **ANSI Compliance:** Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
  - a. Color: White legend on a black field.
  - b. Legend: Indicates voltage and source/service (and termination point for control cables).
- C. **Adhesive Labels:** Preprinted, flexible, self-adhesive vinyl. Legend is laminated with a clear, weather- and chemical-resistant coating.
- D. **Engraved Plastic-Laminated Nameplates:** Provide nameplates for all new equipment to match existing nameplates at site.
- E. **Pre-tensioned, Wrap-around Plastic Sleeves:** Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- F. **Tape Labels:** Embossed adhesive tape with 1/4 inch (minimum) white letters on a black background.
- G. **Colored Adhesive Tape:** Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- H. **Underground Line Warning Tape:** Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
  - 1. Size: Not less than 6 inches wide by 4 mils thick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed Legend: Indicates type of underground line.



- I. **Tape Markers:** Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters for Designation purposes.
- J. **Aluminum, Wraparound Marker Bands:** Wrap-around bands cut from 0.014-inch-thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
  - 1. **Plasticized Card-Stock Tags:** Vinyl cloth with preprinted and field-printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- K. **Copper, Brass or Aluminum Tags:** Metal tags with stamped legend, punched for fastener. Dimensions: Tags shall be circular in shape, two inches minimum diameter, by 0.02 inch thick for copper or by 0.05 inch thick for brass or aluminum.

### 2.3 **Engraved Name Plates and Signs**

- A. **Manufacturer's Standard Products:** Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. **Engraving stock:** Melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 sq. in. or 8 inches in length; 1/8 inch thick for larger sizes. Minimum width of engraving stock shall be 2 times letter height.
- C. **Engraved legend:** Engraved three layer laminated plastic white letters on black background.
- D. **Letter Height:** Lettering for equipment identification shall be 3/8 inch high. Voltage rating and source lettering shall be 1/4 inch high.
- E. **Baked-Enamel Signs for Interior Use:** Preprinted aluminum signs, punched for mechanical fasteners, with colors, legend, and size as indicated or as otherwise required for the application. Use 1/4-inch grommets in corners for mounting.
- F. **Wire and Cable Markers:** Cloth markers, split sleeve or tube type.
- G. **Exterior, Metal-Backed, Butyrate Signs:** Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. Use 1/4-inch grommets in corners for mounting. Signs shall be punched for mechanical fasteners.
- H. **Fasteners for Plastic-Laminated and Metal Signs:** Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- I. **Tape Labels:** Embossed adhesive tape with 1/4 inch (minimum) white letters on a black background.

### 2.4 **Miscellaneous Identification Products**

- A. **Cable Ties:** Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties with the following features:
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength: 50 lb minimum.

3. Temperature Range: Minus 40 to 185 deg F.

- B. **Paint:** Alkyd-urethane enamel over primer as recommended by enamel manufacturer.

### **PART 3 - EXECUTION**

#### **3.1 Installation:**

- A. **Existing Nameplates:** Install nameplates for all new equipment to match existing nameplates on site.
- B. **Consistency:** Use consistent designations throughout the Project
- C. **Sequence of Work:** Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
  1. **Self-Adhesive Identification Products:** Degrease and clean surfaces of dust, loose material, and oily films before applying.
- D. **Raceway/Cable Identification of Special Systems:** Identify raceways and exposed cables of special systems with color banding and black lettering appropriately sized for conduit. Band exposed and accessible raceways of the systems listed below for identification.
  1. **Bands:** Pre-tensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit place adjacent bands of 2-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25 feet in congested areas.
- E. **Circuit Identification Labels on Boxes:** Label externally as follows:
  1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label, as well as "magic marker" on cover.
  2. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- F. **Underground Utility Line Warning Tape:** During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker with metallic tracer located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, use a single line marker.
  1. Install line marker for underground wiring, both direct buried and in raceway.
- G. **Color Code Conductors:** The following field-applied color-coding methods may be used in lieu of factory-coded wire listed in part 2 of Section 16120, "Wires and Cables," for sizes larger than No. 4 AWG. Contractor shall demonstrate non-availability of factory colored wire before using this application
  1. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
    - a. Where conductors are color coded by this method, they shall be color coded in accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors in accessible raceways shall be color coded so that by removing or opening any cover, the coding will be visible.
  2. Green insulated conductors shall not be re-identified for purposes other than grounding.



3. White or neutral gray conductors shall not be re-identified for purposes other than grounded neutrals.

**H. Power Cable Identification:** Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in pull boxes, junction boxes, handholes, switchgear rooms, switchboard rooms, engine generator rooms, UPS rooms, and all electrical closets.

1. Legend: 1/4-inch letter and number, stamping or embossing, with legend corresponding to indicated circuit designations.
2. Fasten tags with cable ties; fasten bands using integral ears.

**I. Conductor Identification for Other Systems:**

1. Install cable tags in each handhole with not less than two tags per cable, one near each duct entrance hole.
  - a. Attach tags to cable immediately after installation.
  - b. Cable terminations shall be tagged as to function.
  - c. Attach securely to cable using 1/8 inch nylon cord.

**J. Signage:** Install warning, caution, and instruction signs as follows:

1. Install signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing in outdoor locations.

**K. Identification Labels:** Install identification labels as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. The first line shall show the equipment ID, the second line shall show the voltage and source.
2. Apply labels for each unit of the following categories of equipment:
  - a. Panelboards, electrical cabinets, and enclosures
  - b. Access doors and panels for concealed electrical items
  - c. Transformers
  - d. Disconnect switches
  - e. Enclosed circuit breakers
3. Apply identification labels of engraved plastic laminate for disconnect switches, enclosed breakers, and similar items for power distribution and control components above, except panelboards where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
4. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
5. Tag cables in each handhole with not less than two tags per cable, one near each duct entrance hole.
  - a. Attach tags to cable immediately after installation.
  - b. Cable terminations shall be tagged as to function.
  - c. Attach securely to cable using 1/8 inch nylon cord.
6. Complete Attachment "A" Panel Schedule for "As Builts", changes and/or revisions.

**END OF SECTION**



**SECTION 16410**  
**DISCONNECT SWITCHES AND CIRCUIT BREAKERS**

**PART 1 - GENERAL**

- 1.1 Summary:** This Section includes furnishing materials, equipment, labor, and incidentals necessary to install individually mounted disconnect switches and circuit breakers used for the following:

1. Feeder and equipment disconnect switches
2. Feeder overcurrent protection
3. Service Disconnect.

**1.2 Reference Standards**

Applicable only to the extent specified.

**A. Federal Aviation Administration**

1. C-1217f Electrical Work, Interior
2. STD-019e Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment
3. STD-020b Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment

**B. Federal Specifications**

1. W-C-375 Circuit Breakers, Molded Case, Branch Circuit and Service
2. W-S-865 Safety Switches

**C. International Electrical Testing Association (NETA)**

1. ATS Acceptance Testing Specification for Electric Power Distribution Equipment and Systems

**D. National Electrical Manufacturer Association (NEMA)**

1. KS 1 Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
2. FU 1 Low Voltage Cartridge Fuses
3. AB 1 Molded Case Circuit Breakers and Molded Case Switches
4. PB 1.2 Application for Ground Fault Protective Devices and Equipment

**E. National Fire Protection Association (NFPA)**

1. 70 National Electrical Code (NEC), latest edition

**F. Occupational Safety and Health Administration (OSHA)**

1. 29CFR1910.7 Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL)

**G. Underwriters Laboratories (UL)**

1. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

**1.3 Submittals**

**A. Product Data for switches, circuit breakers and accessories specified in this Section. Include the following:**

1. Voltage rating
2. Current trip rating
3. Short circuit rating

4. Fuse rating
  5. Type of enclosure
  6. Circuit frame size, trip rating, and number of poles
- B. Field test reports indicating and interpreting test results.
- C. Include outline drawings with dimensions and equipment ratings for voltage, capacity and short circuit.

**1.4 Quality Control:**

- A. **Single Source Responsibility:** Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
- B. **NFPA Compliance:** Comply with NFPA 70 latest edition for components and installation.
- C. **Listing and Labeling:** Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

**PART 2 - PRODUCTS**

**2.1 General:** Materials procured and installed in this Section shall be in accordance with FAA C-1217f, FAA STD-019e, and FAA STD-020b.

**2.2 Fuses:** Refer to Section 16491, "Fuses," for fuse requirements.

**2.3 Disconnect Switches**

- A. **General:** Switches shall be heavy duty, fusible or non-fusible of the voltage, phase, and current ratings indicated on the Contract Drawings. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current carrying parts shall be of high conductivity copper unless otherwise specified, and shall be designed to carry rated current without excessive heating. Switch contacts shall be silver tungsten or plated to minimize corrosion, pitting and oxidation and to assure suitable conductivity. Switch handle shall be lockable in either the "ON" or "OFF" position.
1. Provide lugs to accept more than one conductor per phase as required for application. Landing multiple conductors in a single lug is not acceptable.
  2. Provide 2 padlocks for each switch.
  3. Handle interlocked with cover in the "CLOSED" position.
- B. **Enclosed, Non-fusible Switch:** NEMA KS 1, Type HD
- C. **Enclosed, Fusible Switch:** NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, and provide rejection type fuse clips with switches.
- D. **Enclosure:** NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location:
1. Outdoor Locations: Type 3R.

2. Fabricate enclosure from steel.
  3. Finish using manufacturer's standard enamel finish, gray color.
- 2.4 **Molded Case Circuit Breakers:** NEMA AB 1, UL 489, FS W-C-375, lockable handle, with 2 padlocks complying with FED SPEC W-C-375, and the following requirements:
1. Molded case type
  2. Quick make, quick break connections with mechanical trip, free switching mechanism
  3. Inverse time, thermal trip for overloads. Automatic release secured by bi-metallic thermal element releasing the mechanism latch. Thermal trip calibrated for 40 degree C ambient temperature.
  4. Magnetic armature shall be provided to trip the breaker instantaneously for short-circuit currents above the overload range.
  5. Automatic tripping shall be indicated by a handle position between the manual "OFF" and "ON" positions.
  6. Multi-phase circuit breakers shall have an internal, common trip mechanism to open all poles simultaneously.
  7. Circuit breaker shall have mechanical lugs and power distribution connectors sufficient for the number, size, and material of the conductors indicated. Provide lugs to accommodate multiple conductors per phase as required for application. Landing multiple conductors in a single lug is not acceptable.
  8. Include provisions for padlocking.
  9. Provide poles as indicated on Contract Drawings.
  10. Provide ratings as indicated on contract drawings.
    - a. Minimum interrupt rating at 240V: 22,000 AIC symmetrical
    - b. Voltage rating 120/240V.
    - c. Current rating as indicated on Contract Drawings.

### **PART 3 - EXECUTION**

#### **3.1 Preparation**

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as shown on the drawings.
- C. Verify that required utilities are available, in proper location and ready for hookup.

#### **3.2 Installation**

- A. **Standards Compliance:** Materials installed in this Section shall be in accordance with FAA C-1217f, FAA STD-019e and FAA STD-020b.
- B. **Installation Location:** Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's instructions and as required by the NEC and local codes.
- C. **Installation Practice:** Install disconnect switches level and plumb, and as required by the NEC and local codes.
- D. **Circuit Connection:** Connect disconnect switches, circuit breakers and components to wiring system and to ground as indicated and in accordance with manufacturer's recommendations.
- E. **Torque Settings:** Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.



- F. **Circuit Identification:** Identify each disconnect switch and circuit breaker according to requirements specified in Section 16195, "Electrical Identification."
- G. **Fuse Installation:** Install fuses in fused disconnect switches.
- H. **Fuses:** Refer to Section 16491, "Fuses," for fuse requirements.
- I. **Termination:** Connecting more than one conductor to a phase lug is not acceptable.

**3.3 Field Quality Control**

- A. **Testing:** After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. **Procedures:** Perform each visual and mechanical inspection and electrical tests stated in NETA ATS, Section 7.5 for disconnect switches, Section 7.6 and NEMA AB1 for molded-case circuit breakers. Certify compliance with test parameters.
- C. **Correcting Malfunctions:** Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- D. **Visual Inspection:** Inspect visually and perform several "On-Off" operations on each circuit breaker.
- E. **Circuit Continuity:** Verify circuit continuity on each pole in the closed position.

- 3.4 Cleaning:** After completing system installation, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches and abrasions.

**END OF SECTION**

**SECTION 16470**  
**PANELBOARDS AND OVERCURRENT PROTECTIVE DEVICES**

**PART 1 - GENERAL**

**1.1 Summary:** This Section includes furnishing materials, equipment, labor, and incidentals necessary to install lighting, power and distribution panelboards and associated auxiliary equipment rated 600 V and less.

**1.2 Reference Standards**

Applicable only to the extent specified.

**A. Federal Aviation Administration (FAA)**

- |    |          |  |
|----|----------|--|
| 1. | C-1217f  | Electrical Work, Interior  |
| 2. | STD-019e | Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment |
| 3. | STD-020b | Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment                          |

**B. Federal Specification (FS)**

- |    |         |   |
|----|---------|---|
| 1. | W-P-115 | Panel, Power Distribution                               |
| 2. | W-C-375 | Circuit Breaker, Molded Case Branch Circuit and Service |

**C. Institute of Electrical and Electronic Engineers (IEEE)**

- |    |        |  |
|----|--------|--|
| 1. | C62.41 | Recommended Practice on Surge Voltage in Low-Voltage AC Power Circuits |
|----|--------|--|

**D. National Electrical Manufacturers Association (NEMA)**

- |    |        |  |
|----|--------|--|
| 1. | 250    | Enclosures for Electrical Equipment (1000 Volts or Less)                     |
| 2. | PB1    | Panel Boards   |
| 3. | PB-1.1 | Instructions for Safe Installation, Operation and Maintenance of Panelboards |
| 4. | PB-1.2 | Application Guide for Ground-Fault Protective Devices and Equipment          |
| 5. | AB1    | Molded Case Circuit Breakers and Molded Case Switches                        |

**E. International Electrical Testing Association (NETA)**

- |    |     |  |
|----|-----|--|
| 1. | ATS | Acceptance Testing Specification for Electric Power Distribution Equipment and Systems |
|----|-----|--|

**F. National Fire Protection Association (NFPA)**

- |    |    |  |
|----|----|--|
| 1. | 70 | National Electric Code (NEC), latest edition |
|----|----|--|

**G. Occupational Safety and Health Administration (OSHA)**

- |    |             |  |
|----|-------------|--|
| 1. | 29CFR1910.7 | Definitions and Requirements for a Nationally Recognized Testing Laboratory (NTRL) |
|----|-------------|--|

**H. Underwriters Laboratories (UL)**

- |    |      |   |
|----|------|---|
| 1. | 50   | Electrical Cabinets and Boxes                                     |
| 2. | 67   | Panelboards   |
| 3. | 486A | Wire Connectors and Soldering Lugs for Use with Copper Conductors |
| 4. | 489  | Molded Case Circuit Breakers and Circuit Breaker Enclosures       |

### 1.3 Submittals

- A. **Product Data:** For each type of panelboard, circuit breaker, accessory item and component specified, include outline and support point dimensions, voltage, circuit breaker data arrangement and size.
- B. **Shop Drawings:** For panelboards, include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, voltage, and current rating. Include the following:
  - 1. Enclosure type with details for types other than NEMA 250, Type 1
  - 2. Bus configuration and current ratings
  - 3. Short-circuit current rating of panelboard
  - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components
- C. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article.
- D. **Field Test Reports:** Indicate and interpret test results for compliance with performance requirements. Include certified infrared scanning reports.
- E. **Panelboard Schedules:** For installation in panelboards. Submit final versions after load balancing.
- F. **Maintenance Data:** For panelboard components included in the maintenance manuals specified in Section 16050, "Basic Electrical Materials and Methods." Include manufacturer's written instructions for testing circuit breakers.

### 1.4 Quality Control

- A. **Testing Agency Qualifications:** Independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7, or shall be a full member company of NRTL.
  - 1. Testing Agency's Field Supervision: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3 of this section.
- B. **Listing and Labeling:** Provide products specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled:" As defined in the National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- C. **NFPA Compliance:** Comply with NFPA 70, "National Electrical Code," latest edition.
- D. **NEMA Compliance:** Comply with NEMA PB 1, "Panelboards."
- E. **Single Source Responsibility:** Panelboards and circuit breakers located in the panelboards shall be the product of a single manufacturer.

### 1.5 Extra Materials

**Keys:** Furnish two (2) keys to FAA for each panelboard installed.



## **PART 2 - PRODUCTS**

**2.1     General:** Materials procured in this Section shall be in accordance with FAA C-1217f, FAA STD-019e, and FAA STD-020b.

### **2.2     Panelboard Fabrication**

- A.     **Panelboard Type:** Panelboards shall be of box dead-front type with circuit breaker equipped and shall conform to Federal Specification W-P-115, Type I, Class 1 and shall also be listed by UL except for installations which require special panelboards to incorporate items not available as UL listed.
- B.     **Enclosures:** UL 50, general purpose, galvanized sheet steel, surface-mounted cabinets with a baked-on gray enamel over a rust inhibitor as indicated on the drawings. Panelboards shall be listed and labeled by Underwriters Laboratories, Inc. in accordance with UL Standard 67, and shall conform to the latest requirements of the National Electric Code latest edition, and of NEMA Standard PB 1, Type 1, Class 1, unless otherwise indicated to meet environmental conditions at installed locations.
- C.     **Directory Frame:** Metal, mounted inside each panelboard door.
- D.     **Main Bus:** Hard drawn copper of 98 percent conductivity meet UL 67 temperature rise limits, and have a current density of 1000 amperes per square inch. Bus bars shall be sequenced-phased, and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short circuits. Solderless terminations shall be suitable for copper UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards.
  - 1. Bus capacity as indicated on Contract Drawings, or equal to or greater than the panelboard overcurrent protection device.
  - 2. Bus bars connections to bolt on branch circuit breakers shall be of the sequence phase type.
  - 3. Where provisions for "future" or "space" are noted on the drawings the panelboard shall be equipped with bus connections for the future installation of circuit breakers.
  - 4. Sequence style busing to accept bolt on molded case circuit breakers.
- E.     **Neutral Bus:**
  - 1. The neutral bar shall be fully rated and capable of being located in either corner of the enclosure at the line ends to facilitate conductor termination and shall be insulated from panelboard.
  - 2. Neutral bus bar shall be copper or plated copper, and insulated from panelboard.
  - 3. The neutral bus shall be isolated from all other busses except where the panelboard is used as the service disconnecting means.
- F.     **Equipment Ground Bus:** Ground bus shall be copper, and adequate for feeder and branch-circuit equipment ground conductors with 25% additional space for future connections. Lugs shall be sized to accommodate grounding conductors shown on Contract Drawings.
  - 1. The ground bus shall be securely bonded to the cabinet and shall be separate from the neutral bus.
  - 2. The number of lug terminations shall be at least equal to the number of poles in the panelboard.
  - 3. The ground bus bar shall be structurally integral to the panelboard, or attached to the panelboard with a bolt, nut, and lock washer.
    - a. Bond conductor shall have same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.

- G. **Short circuit rating:** Panelboards shall be fully rated for short circuit. See Contract Drawings for short circuit rating.
- I. **Future Devices:** Equip phase busses with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.
- J. **Panelboard Features:** Include the following special features for panelboards.
1. Hinged Front Door in Door Construction: Entire front trim hinged to box with standard door within hinged trim cover (one-piece front with two doors). The smaller door, when open, provides access to device handles and rating labels and shall be lockable. The larger door, when open, provides access to conductors and wiring terminals. Door hinges shall be continuous piano hinges that are welded to the door(s) and bolt on front. All door hinges shall be concealed.
  2. Channel/Wiring Space: Shall be four inches wide for power feeders up to and including 100 amperes, six inches wide for power feeders over 100 amperes and up to and including 225 amperes, and eight inches wide for power feeders over 225 amperes and up to 600 amperes.
  3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.
  4. Subfeed: Overcurrent protective device or lug provision as shown on Contract Drawings.
  5. Doors shall have flush type cylinder locks and catches. All locks in a project shall be keyed alike, and 2 keys shall be furnished with each lock.
- K. **Wire Gutter Size:** The minimum size of the side wiring gutters shall be 4 inches for power feeders up to and including 100 Amperes, 6 inches for power feeders over 100 Amperes and up to 225 Amperes and 8 inches for panelboards over 225 Amperes up to 600 Amperes.

### 2.3 **Over-current Protective Devices**

- A. **Molded-Case Circuit Breaker:** NEMA AB 1, UL 489, FS W-C-375, and the following requirements:
1. Circuit breaker shall be molded case type.
  2. Circuit breaker shall be bolt-on type. Stab-in and plug-in types are not acceptable.
  3. Quick make, quick break connections with mechanical trip, free switching mechanism.
  4. Inverse time, thermal trip for overloads. Automatic release secured by bi-metallic thermal element releasing the mechanism latch. Thermal trip calibrated for 40 degree C ambient temperature.
  5. Instantaneous magnetic trip armature for short circuits.
  6. Multiple circuit breakers shall have an internal, common trip mechanism to open all poles simultaneously.
  7. Automatic trip indication as a color change in the trip indicator window and by a handle position between the manual "OFF" and "ON" positions.
  8. Single-pole breakers shall be full size modules. Half sized breakers shall not be allowed.
  9. Two and three pole breakers shall be sized in multiples of a single-pole breaker;
  10. Branch circuits shall be connected to the circuit numbers as indicated on Contract Drawings.
  11. UL marked as suitable for use with 75 deg C wire.
  12. Series ratings of breakers shall not be permitted.
- B. **Characteristics:** Provide frame size, trip rating, number of poles, auxiliary devices, voltage rating and interrupting capacity rating to meet available fault current as indicated on Contract Drawings.
1. Minimum interrupting rating: 10,000 AIC.
  2. Where the panelboard interrupting capacity is not indicated on the Contract Drawings, the circuit breaker interrupting capacity shall be equal to or greater than the available fault current at the panelboard.
- C. **Circuit Breakers, 200 A and Larger:** Provide trip units interchangeable within frame size.



- D. **Lugs:** Provide mechanical lugs and power-distribution connectors for number per phase, size, and material of conductors indicated on Contract Drawings.
- E. **Single Manufacturer:** All circuit breakers and the panelboard in which the breakers are installed shall be products of the same manufacturer.
- F. **Mains:** Panelboards shall have either main lugs or main circuit protective device as scheduled.
- G. **Replacement:** Provide bolt-on circuit breakers, replaceable without disturbing adjacent units.
  - 1. Branch circuits shall be connected to the individual circuit breakers as indicated on contract drawings.

#### 2.4 **Accessory Components and Features**

**Accessory Set:** Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

### PART 3 - EXECUTION

- 3.1 **General:** Comply with manufacturer's requirements in accordance with the direction of the Work Release Project Engineer (WRPE) Designee.

#### 3.2 **Installation**

- A. **Materials:** Materials procured and installed in this Section shall be in accordance with FAA C-1217f, FAA STD-019e, and FAA STD-020b.
- B. **Mounting Heights:** Install panelboards and accessory items according to NEMA PB 1.1 and with applicable codes at each location indicated on the plan. Mount the top of the panelboard trim at 78 inches from the ground, unless otherwise indicated.
- C. **Mounting Tall Panelboards:** Panelboards greater than 90 inches tall shall be mounted directly on the floor or maintenance pad, as shown on Contract Drawings.
- D. **Mounting:** Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- E. **Circuit Directory:** Type directory to include installed circuit loads after balancing panelboard loads. The directory shall be arranged so that typed entries simulate circuit breaker positions in the panelboard. The directory shall be mounted on the inside of the door in a holder with a protective covering. Obtain approval from the WRPE Designee before installing.
- F. **Filler Plates:** Furnish and install filler plates for unused spaces in panelboards.
- G. **Wiring in Panelboard Gutters:** Arrange conductors into groups, and bundle with wire ties after completing load balancing.

#### 3.3 **Identification**

- A. **Component Identification:** Identify field-installed wiring as specified in Section 16195, "Electrical Identification."



- B. **Panelboard Nameplates:** Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws, as specified in Section 16195, "Electrical Identification."
- C. **Warning Signs:** Provide warning signs as specified in Section 16195, "Electrical Identification."

**3.4 Grounding:**

- A. **Termination:** Terminate ground connections in panelboards in accordance with Section 16060, "Grounding and Bonding."
- B. **Tightening Torque:** Tighten electrical connectors and terminals, including ground connections, according to the manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.
- C. **Ground Bus Bar:** If ground bus bar is mounted to enclosure with screw threads only, (i.e. tapped blind hole), a separate bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar.

**3.5 Field Quality Control**

- A. **Prepare for acceptance tests as follows:**
  - 1. Measure and record steady-state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits on the panelboards to balance the phase loads within 10 percent.
  - 2. Take care to maintain proper phasing for multi-wire branch circuits.
  - 3. Perform insulation-resistance megger tests of each panelboard bus, component, and connecting supply, feeder, and control circuits to main service ground.
  - 4. Make continuity and phasing tests of each circuit.
  - 5. Perform ground continuity tests on main electrical ground bus to inspect for physical damage, proper alignment, anchorage, and grounding.
  - 6. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- B. **After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.**
  - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA, ATS, Section 7.5 for switches, and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
  - 3. Check each panelboard to insure that it contains a minimum of 20 percent spare capacity for future use.

- 3.6 Adjusting:** Set field-adjustable switches and circuit breaker trip ranges as indicated.

- 3.7 Cleaning:** On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and marred finishes to match original finish.

**END OF SECTION**

**SECTION 16491**  
**FUSES**

**PART 1 - GENERAL**

- 1.1 Summary:** This Section includes the furnishing of equipment, materials, and incidentals necessary to install fuses.

**1.2 Reference Standards**

Applicable only to the extent specified.

**A. Federal Aviation Administration (FAA)**

1. C-1217f Electrical Work, Interior
2. STD-019e Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment
3. STD-020b Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment

**B. American National Standards Institute (ANSI)**

1. C37.40 Standard Service Conditions and Definitions for External Fuses for Shunt Capacitors

**C. National Electrical Manufacturers Association (NEMA)**

1. FU-1 Low Voltage Cartridge Fuses

**D. National Fire Protection Association (NFPA)**

1. 70 National Electrical Code (NEC), latest edition

**E. Occupational Safety and Health Administration (OSHA)**

1. 29CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

- 1.3 Submittals:** Product data for each fuse type. Include the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for fuses with current limiting characteristics.

**1.4 Quality Assurance:**

- A.** Comply with NFPA 70 "National Electric Code," latest edition, for components and installation.

**B. Listing and Labeling:** Provide products specified in this Section that are listed and labeled:

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

- C.** Single-Source Responsibility: All fuses shall be the product of a single manufacturer.

- 1.5 Extra Materials:** Furnish the following extra materials that match products installed, packaged with protective covering for storage, and with identification labels clearly describing contents.

1. Spare Fuses: A complete set of fuses shall be installed and one set of spares shall be furnished for each fusible device.

**PART 2 - PRODUCTS**

- 2.1 **General:** Materials procured and installed in this Section shall be in accordance with FAA C-1217f, FAA STD-019e, and FAA STD-020b.
- 2.2 **Cartridge Fuses:** Characteristics - NEMA FU 1 (low voltage) and Type L (medium voltage) nonrenewable cartridge fuse, class as specified or indicated, current rating as indicated, voltage rating consistent with circuit voltage.

**PART 3 - EXECUTION**

- 3.1 **General:** Comply with manufacturer's requirements for installation.
- 3.2 **Examination**
- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
  - B. Do not proceed with installation until unsatisfactory conditions have been corrected.
- 3.3 **Installation:** Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.
- 3.4 **Identification:** Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

**END OF SECTION**



**SECTION 16510**  
**LIGHTING FIXTURES**

**PART 1 - GENERAL**

**1.1 Summary**

- 1.1.1 Scope** - Extent of electrical work covered by this Section is specified in all other Sections of this specification, the drawings, schedules and by requirements of this Section.

**1.2 Applicable Documents**

**1.2.1 Federal Specifications**

- 1.2.1.1** W-F-414      Fixture, Lighting (Fluorescent, Alternating Current, Pendant Mounting)
- 1.2.1.2** W-F-1662      Fixture, Lighting (Fluorescent, Alternating Current, Recessed and Surface Ceiling)

**1.2.2 National Fire Protection Association (NFPA)**

- 1.2.2.1** No. 70          National Electrical Code (NEC)

**1.2.3 Underwriters Laboratories (UL)**

- 1.2.3.1** UL 542          Lampholders, Starters, and Starter Holders for Fluorescent Lamps

**1.3 Submittals**

- 1.3.1** Include outline drawings, lamp and ballast data, support points, weights and accessory information for each luminaire type.
- 1.3.2** Submit manufacturer's installation instructions under general provisions.

**PART 2 - PRODUCTS**

**2.1 Lamps**

- 2.1.1** Incandescent lamps shall be the size and type as indicated on the drawings and shall be inside frosted and rated for 130 volts, unless otherwise indicated.
- 2.1.2** Fluorescent shall be the length, type, size, wattage and color as indicated on the drawings.

**2.2 Ballasts**

- 2.2.1** All ballasts for fluorescent fixtures shall be Class P, rapid start, high power factor type without thermal resetting capability conforming to Federal Specification W-B-30.
- 2.2.2** All ballasts for fluorescent fixtures shall be provided with factory installed choke type radio frequency interference suppressers.

**2.3     Fluorescent Fixtures**

**2.3.1**     Unless otherwise indicated, fluorescent fixture lenses shall be the prismatic-type, made of virgin acrylic.

**2.3.1.1    Recessed Fluorescent Fixtures** - Recessed fluorescent fixtures shall conform to Federal Specification W-F-1662 and shall be installed in suspended ceiling openings. These fixtures shall have adjustable fittings to permit alignment with ceiling panels. Furnish and install hold down clips for all lay-in type fixtures.

**2.3.1.2    Suspended Fluorescent Fixtures** - Pendant-mount fluorescent fixtures shall conform to Federal Specification W-F-414 and shall be of the types indicated on the drawings. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent units shall have tubing or a stem for wiring at one point, and tubing or a stem suspension provided for each unit length of chassis, including one at each end.

**2.4     Suspended Incandescent Fixtures** - Pendant-mounted incandescent fixtures shall be provided with swivel hangers to insure a plumb installation.

**2.5     Emergency Lights** - Emergency lights shall conform to Federal Specification W-L-305, Type I, Class I, Style D or E, with the number of heads as indicated on the drawings. Emergency light sets shall be connected to the wiring system by a cord no more than 3 feet in length and a single receptacle. Connect the emergency lights to the same branch circuits that provide normal lighting to the area and connect ahead of any local switches.

**2.6     High Intensity Discharge (HID) Lamps** - HID lamps, including mercury vapor, metal halide, and high or low pressure sodium shall be as indicated on the drawings. High power factor, constant wattage ballasts shall be furnished with HID lamps. Mercury vapor lamps shall be the color improved type.

**PART 3 - EXECUTION**

**3.1     Installation**

**3.1.1**     Install lamps in luminaries and lampholders.

**3.1.2**     Install recessed luminaries to permit removal from below. Install grid clips.

**3.2     Relamping**

**3.2.1**     Relamp luminaries which have failed lamps at completion of the work.

**3.3     Adjusting and Cleaning**

**3.3.1**     Align luminaries and clean lenses and diffusers at completion of the work. Clean paint splatters, dirt, and debris from installed luminaries.

**3.3.2**     Touch up luminaire finish at completion of the work.

**END OF SECTION**

**SECTION 16521**  
**EXTERIOR LIGHTING**

**PART 1 - GENERAL**

1.1 **Summary:** This section includes furnishing labor, materials, equipment, and incidentals necessary to install exterior lighting fixtures, lamps, ballasts, pole standards, and accessories.

1.2 **Reference Standards**

A. **American National Standards Institute (ANSI)**

1. C2 National Electric Safety Code
2. C78 Series - Lamps
3. C78.135X Series - high-pressure sodium lamps
4. C78.388 Electric lamps, high-pressure sodium lamps, methods of measuring characteristics
5. C82.4 Ballasts for high-intensity discharge and low-pressure sodium lamps
6. C82.5 Reference ballasts - high intensity discharge and low pressure sodium lamps
7. C82.6 Reference ballasts for high intensity discharge and lamps - methods of measurement

B. **American Standards for Testing and Materials (ASTM)**

1. A500 Cold formed welded and seamless carbon steel structural tubing in rounds and shapes.

C. **National Fire Protection Agency (NFPA)**

1. 70 National Electrical Code (NEC), latest edition.

E. **Occupational Safety and Health Administration (OSHA)**

1. 29CFR1910.7 Description and requirements for a Nationally Recognized Testing Laboratory (NRTL)

F. **Underwriters Laboratories (UL)**

1. 773 Plug-in locking type photo-controls for use with area lighting
2. 1029 High intensity discharge lamp ballasts
3. 1572 High intensity discharge lighting fixtures

G. **Federal Standards (FS)**

1. J-C-30 Cable and wire, electrical

1.3 **Definitions**

A. **Fixture:** A complete lighting device. Fixtures include a lamp or lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.

B. **Lighting Unit:** A fixture or an assembly of fixtures with a common support, including a pole or bracket plus mounting and support accessories.

C. **Luminaries:** A fixture.



#### 1.4 Submittals

- A. Product data describing fixtures, lamps, ballasts, poles, and accessories. Arrange product data for fixtures in order of fixture designation. Include data on features, poles, accessories, finishes, and the following:
  - 1. Outline drawings indicating dimensions and principal features of fixtures and poles.
  - 2. Electrical ratings and photometric data: Certified results of independent laboratory test for fixtures and lamps.
- B. Shop Drawings: Shop drawings detailing wiring for control system showing both factory-installed and field-installed wiring, components, and accessories.
- C. Wiring Diagrams: Wiring diagrams detailing wiring for control system showing both factory-installed and field-installed wiring for specific system of this Project, and differentiating between factory-installed and field-installed wiring.
- D. Product certificates signed by manufacturers of lighting units certifying that their products comply with specified requirements.
- E. Field test reports indicating and interpreting test results specified in Part 3 of this Section.
- F. Maintenance data for products to include in the operation and maintenance manuals.

#### 1.5 Quality Control

- A. **Electrical Component Standard:** Provide components that comply with NFPA 70, latest edition and that are listed and labeled by UL.
- B. Comply with ANSI C2.
- C. **Listing and Labeling:** Provide fixtures and accessories specified in lighting fixture schedule that are listed and labeled for their indicated use and installation conditions on Project.
  - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 2. **Listing and Labeling Agency Qualifications:** A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

#### 1.6 Storage and Handling of Poles

- A. **General:** Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.
- B. **Metal Poles:** Retain factory-applied pole wrappings until just before pole installation. For poles with non-metallic finishes, handle with web fabric straps.

#### 1.7 Warranty

- A. **General Warranty:** The special warranty specified in this Article shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. **Special Warranty:** Submit a written warranty signed by Manufacturer and Contractor agreeing to replace external parts of lighting fixtures exhibiting a failure of finish as specified below.
  - 1. Protection of metal from corrosion: Warranty against perforation or erosion of finish due to weathering.

2. Color retention of housing and pole: Warranty against fading, staining, and chalking due to effect of weather and solar radiation.
3. Special Warranty Period: 5 years from date of Substantial Completion.

#### 1.8 **Extra Materials**

Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Lamps: 1 lamp for every 5 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and other Optical Parts: 1 for every 50 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 1 for every 50 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

### **PART 2 - PRODUCTS**

#### 2.1 **Manufacturers**

- A. **Products:** Provide the lighting units as specified and scheduled on the Contract Drawings.
- B. **Substitutes:** Fixtures specified in the lighting units schedule on Contract Drawings establish a level of quality and appearance that any substituted fixtures must match or exceed. Submit substitutions for the specified fixtures to the FAA for approval.

#### 2.2 **Fixtures and Fixture Components, General**

- A. **Metal Parts:** Free from burrs, sharp edges, and corners.
- B. **Sheet Metal Components:** Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.
- C. **Housings:** Rigidly formed, weather-and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.
- D. **Door, Frames, and Other Internal Access:** Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnected ballast.
- E. **Exposed Hardware:** Stainless steel.
- F. **Reflecting Surfaces:** Minimum reflectances are as follows, except as otherwise indicated:
  1. White Surfaces: 85 percent.
  2. Specular Surfaces: 83 percent.
  3. Diffusing Specular Surfaces: 75 percent.
- G. **Plastic Parts:** High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- H. **Lenses and Refractors:** Materials as indicated. Use heat and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

- I. **High Intensity Discharge (HID) Fixtures:** Conform to UL 1572.
- J. **HID Ballasts:** Conform to UL 1029, and ANSI C82.4, ANSI C82.5, ANSI C82.6, ANSI C78.388X series. Constant wattage auto-transformer (CWA) or regulating high-power-factor type, unless otherwise indicated.
  - 1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
  - 2. Operating Voltage: Match system voltage.
  - 3. Single-Lamp Ballasts:
    - High Pressure Sodium (HPS) minimum starting temperature of minus 40 deg F.
  - 4. Open circuit operation will not reduce average life.
  - 5. HPS Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 80,000 hours at an igniter/starter case temperature of 90 deg C.
  - 6. Noise: Uniformly quiet operation, with a noise rating of B or better.
  - 7. Capacitors:
    - a. Capacitors shall be oil filled with self contained internal protective device and bleeder resistor.
    - b. Capacitors shall be housed in corrosion resistant steel cans and contain 0.25 inch quick disconnect terminals.
- K. **Lamps:** Comply with the ANSI C78 series that is applicable to each type of lamp. Provide fixtures with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a fixture, provide medium wattage lamp recommended by manufacturer.
- L. **Fixture Wiring:** Fixture wiring shall be thermoplastic insulated copper, rated for 600 Volts in accordance with FS J-C-30 and the NEC, latest edition.

### 2.3 **Pole Mounted Fixtures and Components**

- A. **Pole-Mounted Fixtures:** Conform to AASHTO LTS-3.
- B. **Wind Load:** Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, shall be adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mi/h with a gust factor of 1.3.
- C. **Arm, bracket, and tenon mount materials:** Match pole finish.
- D. **Mountings, fastenings, and appurtenances:** Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points.
- E. **Pole shafts:** Round, non-tapered.
- F. **Pole bases:** Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts, and bolt covers.
- G. **Aluminum poles:** ASTM B429, 6063-T6 alloy. Provide access handhole in pole wall.
- H. **Grounding:** Weld or 1/2-inch threaded lug, accessible through handhole.
- I. **Concrete for Pole Foundations:** Comply with Section 03301, "Cast-In-Place Concrete."

### 2.4 **Finishes**



- A. **Metal Parts:** Manufacturer's standard finish, except as otherwise indicated, applied over corrosion-resistant primer, free of streaks, runs, stains, blisters and similar defects.
- B. **Other Parts:** Manufacturers standard finish, except as otherwise indicated.

### **PART 3 - EXECUTION**

#### **3.1 Installation**

- A. **Installing:** Set units plumb, square, level, and secure according to manufacturers written instructions and approved shop drawings.
- B. **Concrete Foundations:** Construct according to Section 03301, "Cast-In-Place Concrete."
- C. **Pole Installation:** Use web fabric slings (not chain or cable) to raise and set poles.
- D. **Fixture Attachment:** Fasten to structural supports or as indicated on drawings.
- E. **Lamping:** Install lamps into fixtures according to manufacturers written instructions. Replace malfunctioning lamps.
- F. **Mounting:** Use mountings that correctly position luminaire to provide indicated light distribution.

#### **3.2 Testing**

- A. **Notice:** Give Work Release Project Engineer (WRPE) Designee 5 day advance notice of dates and times for field tests.
- B. **Record:** Provide instruments to make and record test results.
- C. **Tests and Observations:** Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Operate lighting systems for 72 hours continuously. Include the following.
  - 1. Photometric Test: Measure light intensities at night at locations where specific illumination performance is indicated. Use photometers with calibration referenced to National Institute Standards and Technology (NIST) standards.
  - 2. Check for intensity of illumination.
  - 3. Check for uniformity of illumination.
  - 4. Check for excessively noisy ballasts.
  - 5. Prepare written report of tests indicating actual illumination results.
- D. **Replace or Repair:** Replace or repair malfunctioning units, make necessary adjustments, and reset. Repeat procedure until all units operate properly.

#### **3.3 Adjusting and Cleaning**

- A. Inspect each installed unit for damage. Replace damaged fixtures and components.
- B. Clean units after installation. Use methods and materials recommended by manufacturer.
- C. Adjust aimable fixtures to provide required light intensities.

**END OF SECTION**

**SECTION 16632**  
**PROPANE ENGINE GENERATOR INSTALLATION**

**PART 1 - GENERAL**

- 1.1 **Summary** - This Section includes the installation of all mechanical and electrical items required for the proper operation of a Government-furnished engine generator set, and accessories and Contractor-furnished items. The items to be installed shall include, but not limited to, the engine generator set, engine exhaust system, remote radiator, load bank, battery charger, isolation bypass switch, automatic transfer switch, and associated conduit, wiring and piping.
- 1.2 **References** - The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

**FEDERAL SPECIFICATIONS (FS)**

TT-E-489 Enamel, Alkyd Glass (for Exterior and Interior Surfaces)

TT-P-636 Primer Coating, Alkyd, Wood and Ferrous Metal

WW-P-406 Pipe, Steel (Seamless and Welded) (for Ordinary Use)

**MILITARY SPECIFICATIONS (MIL)**

MIL-T-5544 (Rev. B) (Notice 3) Thread Compound, Anti-Seize, Graphite-Petrolatum

MIL-P-15147 Primer and Enamel, Coal Tar

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**

NFPA 58 1987 Standard for Storage and Handling of Liquefied Petroleum Gases

NFPA 37 1984 Installation and Use of Stationary Combustion Engines and Gas Turbines

NFPA 70 1999 National Electrical Code

- 1.3 **Related Requirements** – Section 16050, Basic Electrical Materials and Methods, applies to this division with the additions and modifications specified herein.
- 1.4 **Quality Assurance**
- 1.4.1 **General** - The Contractor shall be responsible for installation of the engine generator set and its associated equipment. The instructions relative to the installation and the operation of the engine generator set are contained in the Operator's Manual or Instruction Book, furnished with the set. The Contractor shall follow these instructions as required. The spare parts, special tools, and instruction book(s) furnished with the set shall remain in the engine generator room. Fully automatic operation is required for the following operations: engine-generator set starting and source transfer upon loss of normal source; retransfer upon restoration of the normal source. All devices shall automatically reset after termination of their function. The Contractor shall furnish and install all conduit and wiring necessary to interface the automatic devices furnished by the Government.



- 1.4.2 Phase Rotation** - The Contractor shall make certain that the phase rotation of the generator is compatible with that of the incoming commercial lines.
- 1.4.3 Field Engineer** - The Contractor shall be a manufacturer's authorized installer or shall hire a qualified field engineer from the Engine-generator set and the automatic transfer switch manufacturer to assist in the installation of the engine-generator set and ATS, assist in the performance of the onsite tests and instruct personnel as to the operational and maintenance features of the equipment.
- 1.4.5 Operational Test** - The Contractor shall connect the engine generator set and make ready to operate; and provide fuel for the onsite test. Notify the Contracting Officer's Representative when the set is ready for operation. The Contractor shall not attempt to start the engine generator until the installation has been completely checked by the Government Representative. The Contractor shall have a qualified representative present during the operational test and perform any necessary labor to correct installation deficiencies; except that required to correct deficiencies in Government-furnished materials. Contractor shall demonstrate, by means of an operational test designated by the Government Representative, that the complete system, including the automatic transfer switch and associated equipment is complete and operational.
- 1.5 Delivery, Storage, and Handling**
- 1.5.1 General** - All items and materials shall be Contractor-furnished except for those indicated on the Subcontract drawing and/or herein referred to as Government-furnished material. The Contractor shall furnish all materials, labor, equipment, and transportation necessary to satisfy the requirements specified in this Division and/or indicated on the drawings.
- 1.5.2 Care and Handling** - The Contractor shall provide protection for the engine generator and associated equipment from weather, dust, and physical damage. He shall also be liable for all damage while transporting or handling the engine generator, associated equipment, and to the building while installing same until final inspection and acceptance.
- 1.5.3 Contractor's Responsibility to Government-Furnished Materials** - When materials furnished by the Government are turned over to the Contractor, it shall be the Contractor's responsibility to check the materials to see that they are in good condition and that the quantities are sufficient to accomplish the installation required. Should the Contractor find that the quantities of the items listed as being furnished by the Government are not sufficient, he shall immediately notify the Construction Engineering Technician (CET) in writing, so that additional quantities may be obtained without delaying the completion of the installation. After the Contractor has accepted the materials from the Government, all materials lost or damaged will be replaced or paid for by the Contractor.

The Contractor will be responsible for providing suitable storage space for all Government-furnished equipment required to complete the installation. Indoor storage space shall be provided by the Contractor for all equipment which may be damaged if exposed to the elements; out-of-door space will be acceptable for other items which will not be damaged if stored outside.

It shall be the Contractor's responsibility to account for all materials delivered to him by the Government. His final report to the CET shall include a list of all Government-furnished equipment incorporated in the job.



## **PART 2 - PRODUCTS**

- 2.1 General** - The rules, regulations, and reference specifications enumerated herein shall be considered as minimum requirements. They shall not relieve the Contractor from furnishing and installing higher grades of material and workmanship than are specified herein or when so required by the specification drawings.
- 2.2 Materials** - Where the drawings indicate (diagrammatic or otherwise), the work intended and the functions to be performed (even though some minor details are not shown) the Contractor shall furnish all equipment and materials other than Government-furnished items. The Contractor shall be responsible for taking the necessary actions to ensure that all equipment, material, and installation work are coordinated with, and are compatible with the architectural, electrical, mechanical, and structural plans. All materials and equipment to be acceptable, shall comply with all subcontract requirements. Materials furnished by the Contractor under this specification shall be new and the standard product of the manufacturer's latest designs that comply with the specification requirements. Wherever standards have been established by Underwriters Laboratories, Inc., the material shall bear the UL label.
- Departures from exact dimensions shown in the drawings are permitted where required to avoid conflict or unnecessary difficulty in placement of the dimensioned item, provided all other Subcontract and proposal requirements are met; however, the Contractor shall promptly notify the CET of any such departure.
- The total of Government furnished equipment remaining after completion of the work shall be the total of the equipment received from the Government at the beginning of the project.
- Materials and equipment furnished by the Government in excess of that required to complete the installation shall be returned to the CET upon completion of the installation.
- 2.3 Workmanship** - All installation work shall be done by competent and experienced workman regularly engaged in this type of work in conformance with established standards. When required by local Government, the workman shall have a current license to engage in this type of work.
- 2.4 Engine Accessories** - The Contractor shall provide the following accessories for installation of the engine generator set:
- a. Foundation bolts, nuts, isolators, and sleeves for engine generator set.
  - b. Chocks and shims for installation and leveling of engine generator set subbase, if applicable.
  - c. Flexible fuel lines and radiator piping hoses.
  - d. Exhaust piping.
- 2.7 Wire and Cable** - Provide wire and cable required for a complete electrical system as shown. Comply with the requirements specified in Division 16120, Wire and Cable.

## **PART 3 - EXECUTION**

- 3.1 Installation** - Installation shall be in strict accordance with manufacturer's instructions. Provide labor, tools, equipment, and other necessities for erection and installation of the equipment. Use cribbing and shoring as required to protect construction from moving-in damage. Protect flooring and finished surfaces with heavy planking. After equipment has been installed, remove shoring and repair damage to floors and other parts of the building.
- 3.1.1 Installation of Engine Generator Sets** - Install engine generator set on a concrete foundation as indicated. Install vibration isolators to isolate vibrations from the engine generator set to the foundation. The engine generator bed plate shall be mounted on eight vibration pads as recommended by the engine generator manufacturer. In the event the bed plate is not uniformly supported by the pads, shim

between the bed plate and the pad to ensure proper support. The engine generator shall be anchored to the concrete pad at all four corners of the skid through the factory drilled holes in the skid plate.

- 3.1.2 Equipment Supports and Installation** - Provide devices to support equipment not supported on the engine generator structural steel subbase as required. Fabricate the required supports of structural steel sections, plates or rods, and arrange to provide rigid and sturdy support. Provide connections and fasteners required between equipment supports and building structures.
- 3.1.6 Wiring** - The Contractor shall install all switches, breakers, distribution panels, and control cabinets, as required, in the engine generator room in accordance with the applicable Divisions of this specification. The Contractor shall run all conduits, and wiring between the entrance switch or breaker, isolation bypass switch, automatic transfer switch, generator control cabinet, distribution panel(s), load bank, and load bank control cabinet, starting batteries, and radiator in accordance with the installation drawings. The Contractor shall identify all switches and cabinets with name plate per specification on the front of each item of equipment, the function, voltage, and phase of the piece of equipment.
- 3.1.7 Starting Batteries** - Batteries will be furnished by the Government. Interconnecting cables and connection hardware between the engine and batteries are also furnished by the Government. Cables from the battery bank to the battery charger are not Government-furnished and are to be furnished and installed by the Contractor. During construction period, follow manufacturer's instructions for protection of the batteries from environmental damage. Several days before starting the engine generator, or when so directed by the Contracting Officer's Representative, the Contractor shall place the batteries on the charger to equalize their charge.
- 3.1.8 Load Bank** - The load bank will be Government-furnished. The Contractor shall install the load bank as shown on the engine generator installation drawing, together with the associated equipment including all conduit, conductor, and fittings.
- 3.1.9 Paint Touch-Up** - The Contractor shall touch up all rust spots and scratches on the engine generator and associated equipment. Rusted areas shall be sanded down and primed with Primer Coating, Alkyd, Wood and Ferrous Metal conforming to Federal Specification TT-P-636. The areas shall then be painted with Alkyd Gloss Enamel conforming to Federal Specification TT-E-489, matching the existing paint on the engine generator and associated equipment, as near as is possible.

**END OF SECTION**



**SECTION 16670**  
**LIGHTNING PROTECTION**

**PART 1 - GENERAL**

**1.1 Summary:** This Section includes the furnishing of labor, material, equipment and incidentals necessary to install a complete lightning protection system for buildings and associated structures and requirements for lightning protection system components in accordance with UL 96A, NFPA 780 and this specification.

**1.2 Reference Standards**

Applicable only to the extent specified.

**A. Federal Aviation Administration (FAA)**

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|----|----------|--|
| 1. | C-1217f  | Electrical Work, Interior  |
| 2. | STD-019e | Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment |
| 3. | STD-020b | Transient Protection, Grounding, Bonding, and Shielding Requirements for Electronic Equipment                          |

**B. National Fire Protection Association (NFPA)**

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|----|-----|--|
| 1. | 780 | Lightning Protection Code                      |
| 2. | 70  | National Electrical Code (NEC), latest edition |

**C. National Institute of Standards and Technology (NIST)**

**D. Occupational Safety and Health Administration (OSHA)**

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|----|-------------|--|
| 1. | 29CFR1910.7 | Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL) |
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**E. Underwriters Laboratories (UL)**

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|----|-----|--|
| 1. | 96  | Lightning Protection Components                            |
| 2. | 96A | Installation Requirements for Lightning Protection Systems |

**F. Lightning Protection Institute (LPI)**

- |    |         |   |
|----|---------|---|
| 1. | LPI-175 | Lightning Protection Standard of Practice |
|----|---------|---|

**1.3 Submittals**

**A. Product Data:** Product Data for each component specified. Include the following:

1. Roof adhesive data.
2. Decorative air terminal illustrations.

**B. Shop Drawings:** Shop Drawings detailing the lightning protection system, including but not limited to type, size, air terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.

**C. Qualification Data:** Qualification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.



- D. **Product Certificates:** Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
- E. **Field Test Reports:** Field inspection reports indicating compliance with specified requirements.
- F. **Specifications:** Manufacturer's product specifications.
- G. **Catalog Cuts:** Product catalog cut sheets provided by the product manufacturer.

#### 1.4 **Quality Control**

- A. **Installer Qualifications:** Engage an experienced installer who is certified by the Lightning Protection Institute as a Master Installer/Designer to install lightning protection system.
- B. **Listing and Labeling:** Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations and that can determine compliance with appropriate standards for the current production of listed items.
  - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- C. **NFPA Compliance:** Comply with NFPA 70 "National Electric Code," latest edition.
- D. **UL Compliance:** Conform to UL 96A and provide UL Master Label.
- E. **Certification:** Conform to the most stringent requirements of the following standards.
  - 1. LPI Certification of the System.

- 1.5 **Sequencing and Scheduling:** Coordinate installation of lightning protection with installation of other building systems and components including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

## **PART 2 - PRODUCTS**

### 2.1 **Lightning Protection System Components**

- A. **Materials:** All equipment shall be UL approved and marked in accordance with UL procedures. All equipment shall be new and of a design and construction to suit the application in accordance with UL 96A requirements. Bronze and stainless steel may be used for some components. Aluminum material shall not be in contact with copper material and bimetal connector shall be used for interconnecting copper and aluminum.
  - 1. All materials shall be copper and bronze and of the size, weight and construction to suit the application where used in accordance with UL, NFPA, NEC code requirements for this type structure and as per manufacturer's recommendation. Class I sized components may be utilized on roof levels 75 feet and below in height. With the exception of the cable holders, all connectors and splices utilize exothermic weld connections.
  - 2. Aluminum material may not be used except on roofs that require aluminum components in order to be compatible with aluminum roofing materials. In this case, mechanical connectors may be used. Suitable transition joints, properly installed by trained personnel are required between aluminum and copper conductors.
- B. **Air Terminals:** Air terminals shall meet the following requirements:

1. Air terminals shall be UL approved and shall be solid copper, aluminum or bronze. Copper air terminals may be nickel plated. The minimum sizes are 1/2 inch in diameter for solid copper or bronze air terminals, and 5/8 inch in diameter for solid aluminum air terminals. Air terminals shall be a minimum of 12 inches in height, and shall have a rounded or "bullet" tip.
  2. Air terminals shall be tapered to a blunt point and shall extend at least 10 inches above the object or area they are designed to protect. Wherever a risk of injury exists from falling and striking an air terminal, the tip of the air terminal shall be not less than 5 feet above the walking or working surface.
  3. Rod and support shall be designed to handle a 75 pounds per square foot wind load.
- C. **Conductors:** Conductors shall meet the following requirements:
1. All lightning protection conductors shall be sized in accordance with NFPA 780, Table 3.1.1 (a) "Minimum Class I Material Requirements."
  2. Copper conductors shall be manufactured of copper grade ordinarily required for commercial electrical work, designated as being 98 percent conductive when annealed.
  3. Down conductors shall be of copper cable and weigh not less the 187.5 pounds per 1000 feet and the size of any wire of this cable shall not be less than #17 AWG (0.045 inch) and shall be tinned.
  4. The thickness of any copper ribbon or strip shall not less than #16 AWG (0.051 inch).
  5. Copper conductors used shall not be less than #15 AWG (0.057 inches) or as shown on the drawings.
  6. Conductors used for bonding these metallic bodies shall be Class I secondary conductors in accordance with NFPA 780.
- D. **Hardware:** Hardware shall meet the following requirements:
1. Fasteners: Fasteners shall be of the same material as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Galvanized or plated materials shall not be used.
  2. Fittings: Bonding devices, cable splices, and miscellaneous connectors shall be suitable for use with the installed conductor with exothermic weld. Bolt pressure connections of secondary conductors may be acceptable where indicated on drawings. Cast or stamped crimp type fittings shall not be used.
- E. **Guards:** Guards shall meet the following requirements:
1. Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they may be displaced or damaged.
  2. Guards shall extend to roof level, and 6 foot above and 1 foot below grade level
  3. Guards shall be schedule 40 PVC where feasible.
  4. Metal guards may be used, but shall be bonded to the down conductor at both ends.
  5. Bonding jumpers shall be of the same size as the down conductor.
  6. PVC guards do not require bonding.
  7. Crimp type connections shall not be used, only exothermic welds are acceptable.

### **PART 3 - EXECUTION**

#### **3.1 General**

- A. Comply with manufacturer's requirements in accordance with the direction of the Work Release Project Engineer (WRPE) Designee.
- B. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of Lightning Protection System. Do not proceed with installation until unsatisfactory conditions have been corrected.



- C. The contract drawings indicate the extent and general arrangement of the Lightning Protection System.

### 3.2 **Installation**

- A. **Installation standards:** Installation shall conform to UL standard 96A. Installer shall provide an Underwriters' Laboratories Master Label for the facility. Installation shall also comply with NFPA 780, FAA C-1217f, FAA STD-019e, FAA STD-020b.
1. Conform to the most stringent requirements when more than one standard is specified.
- B. **Conductor and conduit routing:** Down conductors shall maintain a horizontal or downward course. No bend in a roof or down conductor shall form an included angle of less than 90 degrees, nor shall it have a bend radius of less than 8 inches. Conductors shall be routed external to buildings and 6 feet or more from power or signal conductors.
- C. **Down conductor terminations:** Down conductors shall be used to ground air terminals conductors from 2 feet to 6 feet outside the foundation or exterior footing of a building. Down conductors shall be connected to the ground rods by exothermic welding. Provide number of down conductors indicated on drawings. Down conductors shall be routed outside of any structure and shall not penetrate or invade that structure. All down conductors except one may be provided with a screw type connector as described in UL 96 where lightning protection testing may be required. Down conductors shall be supported from and secured to the building exterior using one-hole straps of copper or bronze at maximum intervals of three (3) feet.
- D. **Down conductor routing:** Route down conductors outside of building facade in Schedule 40 PVC conduit. Submit system plan which indicates exact location of down conductors, as well as intended equipment locations, to WRPE Designee for approval prior to installation.
- E. **Air terminal attachment:** Air terminals shall be located in accordance with the requirements of NFPA 780 and UL 96A. All air terminals shall be secured against overturning either by attachment to the object to be protected, or by means of braces that are permanently and rigidly attached to the building.
- F. **Metallic bodies subject to induced charges:** Metallic bodies, on or below roof level, that are subject to induced charges from lightning include exhaust fans, metal cooling towers, HVAC units, railings ladders, antennas, roof drains, plumbing vents, metal coping, metal flashing, downspouts, small wall vents, door and window frames, metal balcony railings and generally any isolated metallic body within 6 feet of an exposed lightning protection system element. These metallic bodies shall be bonded to the nearest main Lightning Protection System using UL approved splicers, fittings and conductors.
- G. **Metallic bodies subject to direct lightning discharge:** Metallic bodies on roofs subject to direct lightning discharge are generally any large metallic body whose size causes it to protrude beyond the zone of protection of the installed air terminals. This includes antenna support structures, exhaust fans, flues, ladders, railings, and roof hatches. When these metallic bodies have a metal thickness of 3/16 inches or greater, they shall be bonded to the nearest main lightning protection system conductor with UL approved fittings and conductors meeting the requirements of NFPA 780. These bonding fittings shall provide surfaces of not less than 3 square inches. Provisions shall be made to prevent corrosive effects introduced by galvanic action of dissimilar metals at bonding points. If the metal parts of these units are less than 3/16 inches thick, additional approved air terminals, conductors, and fittings, providing a two-way path to ground from the air terminals, shall be installed.



**3.3     Corrosion Protection**

- A.     Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.
- B.     Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

**3.4     Field Quality Control**

- A.     **Periodic inspections:** Provide the services of a qualified inspector to perform periodic inspections during construction and at its completion, according to LPI-175.
- B.     **UL inspection:** Apply for inspection by UL as required for UL master labeling of system.
- C.     **ETL inspection:** Provide the services of ETL to inspect completed system for conformance with specified requirements.
- D.     **Periodic quality control testing:** The Contractor shall establish and maintain quality control for the lightning protection system installation to assure compliance with contract requirements and shall maintain records of his quality control for all construction operations. A copy of these records and contractor tests, as well as the records of corrective action taken, shall be furnished to the Contractor as directed by the WRPE Designee. Contractor shall obtain an Underwriter's Laboratories Master Label for the facility.

**3.5     Testing**

- A.     **Resistance-to-ground testing:** Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by treating soil proximity to ground rods with sodium chloride, copper sulfate, or magnesium. Retest to demonstrate compliance.
- B.     **Testing of the continuity of all conductors:** A copy of these records and tests, as well as the records of corrective action taken shall be furnished to the FAA.

**END OF SECTION**